ACE Technology lecturers' and in-service teachers' understanding of the design process and its enactment in their pedagogical practice

by

Bongeka Petunia Mabaso

Thesis submitted in fulfillment of the requirements for the degree of Masters in Technology Education in the Cluster of Science and Technology Education
University of KwaZulu-Natal

Supervisor:
Dr. B. P. ALANT, UKZN
2014

ABSTRACT

This thesis is an exploration of Advanced Certificate in Education (ACE) Technology lecturers' and in-service teachers' understanding of the design process and how it influences their pedagogical practice. Creativity, critical thinking, problem-solving capabilities and other related skills are key aspects of Technology Education. In order for Technology learners to develop these capabilities and skills they need to engage with the design process. It is in this regard that the design process is argued to be the core of technology education. Hence, it is argued that it ought to be used to structure and drive the delivery of all learning aims of the Technology subject in South African schools. Research shows that the context based and complex nature of the design process presents a huge challenge for teachers. As a result, teachers present it as a linear process, rather than an iterative process as suggested in the South African Curriculum and Assessment Policy Statement for Grades 7-9 Technology. The two research questions explored were: "*What are ACE Technology lecturers' and in-service teachers' understanding of the design process?*" and "*What informs and influences Technology Education lecturers' and in-service teachers' understanding of the design process?"* These questions were addressed through the use of a questionnaire and two focus group interviews with the ACE Technology lecturers' and teachers'. Schön's notions of reflection-in-action and reflection-on-action were used to trace how these ACE Technology lecturers' and teachers' developed their understanding of the design process. The results indicate that through the use of reflection in and on action, ACE Technology lecturers' and teachers' understanding of the design process broadens and changes. Reflection occurred by means of narrative, graphic presentations and participative engagement methods.

W.r.t. to Research Question 1, four conceptions of the relationship between the design process and problem solving emerged which then led to the emergence of the seven ways in which the design process is understood:

Conception 1: Design process is action orientated.

Conception 2: Design process is not linear, but iterative.

Conception 3: Design process is solution based.

Conception 4: Design process is appraisal and evaluation.

Conception 5: Design process is systematic.

Conception 6: Design process is complex.

Conception 7: Design process is context based.

With regard to Research Question 2, the findings revealed two factors that influence and inform ACE lecturers' and teachers' understanding: *a) reflection and interacting in a community of practice* and *b) the interface between understanding and practice*. This interface is premised upon two factors which cause understanding to be transformed and confirmed during practice: *(i) contextual issues* and *(ii) identity*. In this regard, the analysis of data from this study shows that ACE technology lecturers' and in-service teachers' understanding of the design process not only directs their pedagogical practice but impacts on learning of Technology with respect to critical thinking, innovation and creativity.

DECLARATION

I, Bongeka Petunia Mabaso declare that "**ACE Technology lecturers' in-service teachers' understanding of the design process and its enactment in their pedagogical practice"** is my own work and that all the sources I have used or quoted, have been indicated and acknowledged by means of complete references.

Researcher: Bongeka Petunia Mabaso

Supervisor: Dr Busisiwe P. Alant

ETHICAL CLEARANCE CERTIFICATE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

21 January 2015

Mrs Bongeka Petunia Mabaso 955024774
School of Education
Edgewood Campus

Protocol reference number: HSS/0636/012M
Project title: ACE Technology lecturers' and in-service teachers' understanding of the design process and its enactment in their pedagogical practice.

Dear Mrs Mabaso

Approval - Change of project title

I wish to confirm that your application in connection with the above mentioned project has been approved.

- **New project title approved.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach/Methods must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number. Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

Best wishes for the successful completion of your research protocol.

Yours faithfully

....
Dr Shenuka Singh (Chair)

/px

cc Supervisor: Dr B Alant
cc Academic Leader Research: Dr D Davids
cc School Administrators: Ms B Bhengu, Ms T Khumalo, Mr S Mthembu

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

v

DEDICATION

This thesis is dedicated to my family, my father Solomon Thabiso Sjabulile Mngqiti and my late mother Dorrance Thembekile Mngqiti may her soul rest in peace. My loving husband Mdukhy for being patient and my children Siphiwe, Lulama and Anathi.

ACKNOWLEDGEMENTS

First and foremost I would like to thank God for granting me the wisdom to engage in a study of this nature. I thank him for keeping me alive and helping me through this dissertation especially during the times when I thought of giving up and tended to lose hope. I would like to express my thanks to the following people for their contribution to this research study.

To Dr. Busisiwe Alant for making the impossible possible, for her expert advice, support, motivation and effort that she afforded me in the completion of this thesis.

To Prof Gregory Kamwendo and Prof Morojele for their support and for giving me time to complete this study.

To Dr Asheena Singh Pillay for your encouragement and motivation during the whole process of my research study.

To my sister Busisiwe Goba for being there for me whenever I need clarity and for your emotional and spiritual support.

To Dagogo William Legg-Jack for your assistance in drawings and motivation.

To my participants especially Debbie Bosch, Elizabeth Arnold, Marion and Rod Sherwood without you this study would not exist.

To my children for their support and patience and allowing me to take their quality time to complete the study. I also thank my husband, Mdukhy, for his unconditional love and support, for taking on the extra duties when I was busy and for giving me the space to complete this project. A special word of thanks goes to my family and friends for their understanding, for all the times that I was unavailable.

ABBREVIATIONS

CAPS:	Curriculum and Assessment Policy Statement
RNCS:	The Revised National Curriculum Statement
ACE:	Advanced Certificate in Education
D.S.	Design Process
ERS:	Education Renewal Strategy
P.S:	Problem Solving
EDP:	Engineering Design Process
PCK:	Pedagogical Content Knowledge
OBE:	Outcomes Based Education
UK:	United Kingdom

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1: CONTEXTUALISING THE STUDY

The South African Government recognized Technology Education in 1997 as an official subject in the school curriculum which marked a new beginning in the teaching and learning of Technology Education (Chapman, 2002). However as a new subject it underwent many changes over the past decades coupled with challenges. When a new curriculum is introduced it is prone to misunderstanding which can lead to misconception as well as misinterpretation (Pudi, 2007). The misinterpretation may inhibit the proper implementation and growth of the subject. When a curriculum is put into practice, its meaning and aims are interpreted by teachers as well as other agents such as textbook writers. Teachers play an important role in transmitting intentions of education to the recipients which are learners (Bungum, 2006). Within the South African curriculum the general aims of education is to ensure that children acquire and apply knowledge and skills in ways that are meaningful to their own lives (Department of Basic Education, 2011). In Technology Education it is through the application of the design process that learners are be able to achieve the general aims of education.

1.1 HISTORICAL BACKGROUND

Before 1994 education in South Africa was segregated along racial and ethnic lines. The introduction of Technology Education as a learning area in the South African General Education and Training curriculum in 1996 was the result of a fairly extensive development process which started with the proposal and recommendations made by the Education Renewal Strategy (ERS, 1992) and the Walters Report (Stevens, 2006). Subsequently, a new curriculum framework C2005 was introduced featuring eight compulsory ‘learning areas’ guided by the philosophy of Outcomes Based Education (OBE), with critical outcomes. This new framework came up with lots of demands. The load fell deeply on the shoulders of the teachers. Teachers had to master the overabundance of new terms and language, and they were expected to interpret the new curriculum into implementable classroom activities (Stevens, 2006). The introduction of the new curriculum had its own challenges; teachers were trained through the cascade model which failed (Stevens, 2006). Due to challenges experienced C2005 was replaced by the National Curriculum Statement (NCS) which became policy in 2002. The NCS considered the design process to be the backbone of learning outcomes (Potgieter, 2013). However due to challenges in the implementation the NCS was also revised and then replaced in 2011 by the new Curriculum and Assessment Policy Statement (CAPS) which dictates the use of design process to drive specific aims. It is against this background that the study seeks to explore ACE lecturers' and teachers' understanding of the design process.

1.2 CONTEXT OF THE STUDY

Although a lot of research indicates that neither students nor designers use a linear process or any predetermined process in their technological practice, the presentation of the design process as a linear process continues to dominate classroom practice, especially in Technology Education (Anning, 1997; Fleer & Sukroo as cited in Fleer, 2000; Mawson, 2003; McCormick, Murphy, & Hennessy, 1994). For example McCormick et al. (1994) conducted a study which focused on the nature of problem solving in Technology Education and found that students do not use a prescribed, linear process but follow a flexible approach during problem solving. However, when problem solving occurs in the context of a test, the authors noted that students would rather use the teachers' approach in order to satisfy the assessment requirements.

This study therefore seeks to engage and contribute to the debates and research on what is perceived to be one of the greatest challenges faced by Technology teachers, namely, how to simultaneously develop creativity, critical thinking and innovation in order to meet the intrinsic curriculum expectations of providing structure to learning experiences. Therefore, this study seeks to explore ACE Technology lecturers' and in-service teachers' understandings of the design process, and what informs and influence these understandings. This is conducted in order to explore ways in which these understandings can be used to enhance classroom practice and research in the teaching and learning of Technology.

Creativity, critical thinking, and problem-solving capabilities and skills are key aspects of Technology Education (Gustafson & Rowell, 1998; Hill, 1998; Middleton, 2005; Mioduser & Dagan, 2007). According to Mioduser and Dagan (2007) the above capabilities and skills can be developed by providing students with authentic real-life problem contexts. These authors further argue that in order for Technology students to develop these capabilities and skills, they need to engage with the design process. Having said this, teachers' conceptions of the design process might pose challenges in achieving this goal: on the one hand, the design process is thought of as a creative, branching, iterative and cyclical process reliant on multidisciplinary knowledge, and on the other it is perceived as a product-based process aimed at meeting the requirements of the Technology curriculum.

According to Williams (2000) the latter understanding of the design process has led to a common approach among teachers in the teaching of the design process in Technology Education. A series of steps are outlined by the teachers, viz. identify-design-make-appraise, and students are expected to follow them diligently in their projects. The ideology behind this systematic process, Williams argues, is that it can be taught. Learners who learn it can then apply it in different problem-solving contexts (Williams, 2000). This rigid procedure is inviting to teachers, because it provides a structure for the teaching of Technology.

Arguing along the same lines is Mawson (2003) who confirms that the rigid, linear approach to problem solving in Technology Education still dominates in schools. According to him, teachers tend to structure designing activities as sequential rather than iterative. As a result, the emphasis on the linear model during Technology teaching and learning changes the design process into a series of products (Mawson, 2003). It is in this regard that Kimbel (as cited in Mawson 2003) cautions against presentation of the design process as a simple, linear, systematic process. He likens the process of engaging in the design process as that of "constructing order from disorder". As argued by Lawson (2006, p .48-49) "the design process as a complex process, stems from its cyclical and iterative nature". In this regard, possible solutions come from a complex interaction between *parallel refinements* of the design problem and ever changing design ideas (Lawson, 2006). According to Kimbel, it is this complex and dynamic nature of the design process, which involves engagement in an iterative process that needs to be brought to the fore in our teaching and learning of Technology.

1.3 PURPOSE OF THE STUDY

This study seeks to explore technological practice. It focuses on Advanced Certificate in Education (ACE) Technology lecturers' and in-service teachers' understanding of the design process and their pedagogical practice. The aim is to get a better understanding of what are ACE Technology lecturers' and in-service teachers' understandings and to investigate what informs and influence their understanding.

1.4 SIGNIFICANCE OF THE STUDY

This study seeks to engage and contribute to the debates and research on the challenge faced by teachers on how to develop creativity, critical thinking and innovation in order to meet the intrinsic curriculum expectations of providing structure to learning experiences within the South African context. By exploring lecturers' and teachers' understanding of the design process and what informs and influence such understandings it is hoped that the study will enhance classroom practice in teaching and learning of Technology education. This will benefit teachers' curriculum developers and other stakeholders involved in Technology Education.

1.5 CRITICAL QUESTIONS

The research questions which were explored in this study are as follows:

1. What are ACE Technology Education lecturers' and in-service teachers' understanding of the design process?
2. What informs and influences Technology Education lecturers' and in-service teachers' understanding of the design process?

1.6 RATIONALE

I have been a Technology Educator at school level for fourteen years. I was teaching Home Economics and Technology with the knowledge gained through Departmental workshops which only lasted for one to two weeks. As the Head of the Technology Department, I found myself struggling to teach Technology effectively and mentor my team appropriately. I then developed myself by acquiring an Advanced Certificate in Technology. Having gained this qualification I observed that teachers are battling with the implementation of the subject as they use textbook methods and neglect the practical side of the learning area. Those who would try to include capability tasks focus on the end product. When students display their products for assessment emphasis is put on beauty. Learners are required to write a portfolio afterwards but in the portfolio steps of the design process are used merely as a checklist. These problems seemed to emanate from the lack of competence of teachers as well as a lack of resources. In addition the evolution of the subject has resulted in a situation where teachers are required to deliver a different curriculum from which they were originally trained for.

Alongside my academic progress my involvement with the basic course in Technology Education, ACE programme, the Bachelor of Education programme within the University of KwaZulu-Natal led to my progress in understanding more about Technology Education. Anecdotal evidence from in-service teachers in the ACE programme has been that teachers tend to confuse the resource tasks and capability tasks. In their teaching practice assignments I noticed that capability tasks (design process) also serve as resource tasks. However the main aim of technology is developing technological literacy. The aim of technological literacy is to develop problem solving capabilities and skills by engaging learners in the design process as it is used by technologies to create solutions in response to real life needs. Thus, my observations led to the big question of trying to explore teachers understanding of the design process.

1.7 OVERVIEW OF THE STUDY

This chapter has provided an introduction as well as context for the study. The chapter has discussed the research questions, describing why the questions are important and relevant to the study. A description of the significance of the study and rationale for conducting the study is presented. The chapter has provided a thick description of the importance of the design process in Technology Education.

Chapter 2 provides discussion of literature relating to conceptions of the design process and its challenges. The chapter also discusses the nature of design, technological practice and approaches to technological practice. It then moves to discussing the theoretical framework which guides the study.

Chapter 3 outlines the methodology and provides detail of the research design. It therefore discusses the instruments, sampling, data analysis, ethical considerations, limitations and issues of reliability.

Chapter 4 presents data analysis regarding the first research question. This chapter provides a detailed analysis of the participants' understandings as drawn from the questionnaire, focus groups and graphical representation.

Chapter 5 presents the data analysis regarding the second research question. This chapter focuses on what informs and influences the participants' understandings. Focus groups interviews were used as a means of collecting data.

Chapter 6 of the thesis draws out the key findings and shows how the results can be used in helping Technology Education teachers and lecturers develop a conscious understanding of the dynamics of the design process and how it benefits not only to the learners, but the field at large. The dissertation concludes with recommendations for further research and study.

1.8 OPERATIONAL TERMS

The definitions of the operational terms used in the study are given below. These definitions allow for the reader to understand my standpoint as a researcher.

1.8.1 Technology

Within this study I refer to Technology as stated in the South African curriculum documents as "the use of knowledge, skills, values and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration" (Department of Basic Education, 2002, 2011). Technology teaches learners to combine designing skills and making skills together with creative knowledge and understanding so as to design and make products for their intended purpose. Hill (1998) accords with the description in the South African curriculum that technology is the use of materials, skills and knowledge to create artefacts, systems, processes or even new knowledge to meet human needs in a context of human and environmental considerations through open-ended problem solving. The subject contributes towards technological literacy by providing students with the opportunity to solve real life technological problems.

1.8.2 The Design Process

In the curriculum documents of South African public schools the design process is regarded as the core of technology education which should be used to structure delivery of the learning aims (Education, 2002, 2011). The design process is described as "a creative and interactive approach used to develop solutions to identified problems or human needs" (Department of Basic Education, 2002, 2011). The process incorporates a range of skills such as investigative, designing, making, evaluating and communication skills (Department of Basic Education, 2011). The design skills are used in problem solving. Lawson (2006) states that the design process is regarded as a complex process and this stems from its cyclical and iterative nature. Therefore solutions come from a complex interaction between parallel refinements of the design problem and ever changing design ideas. It is a process of trying out meaning through practical moves, described by Hill (1998) as "constructing order from disorder".

1.8.3 Problem Solving

The department of education identifies problem solving using the design process as one of the key issues to teach technology education (Department of Basic Education, 2011). It is the design process that guides problem solving.

1.8.4 Technological practice

Technological practice is the way technological solutions are developed. It involves the use of technological knowledge, materials, a comprehension of social issues together with practical skills to produce technological solutions (Smits, 2000). Technological practice is a total description of all thinking, moves and interaction that transpire in any technological undertaking.

1.8.5 Reflective practice

According to Schön (1987) reflective practice consists of two components, namely, reflection-in-action and reflection-on-action.

1.8.6 Reflection-in-action

Reflection-in-action refers to reflecting on action during the event in addition to the application of knowledge in action which leads to on-the-spot adjustments. Reflection-in-action involves constructing new understandings to inform new moves in the situation that is unfolding.

The practitioner allows themself to experience surprise, puzzlement, or confusion in a situation which is uncertain, or unique. They reflect on the phenomenon before them, and on the prior understandings which have been implicit in their behaviour. They carry out an experiment which serves to generate both new understanding of the phenomenon and a change in the situation (Schön, 1983, p.68).

1.8.7 Reflection-on-action

Reflection-on-action takes place after an action has occurred, when the individual thinks about what they did, evaluating how successful they were and whether any adjustments to what they did could bring about a different result. Eraut (1994) interprets Schon's reflection-on-action as a way of making sense of an action in the past and possibly learning from the experience which extends ones' knowledge base.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This chapter surveys literature on current studies pertaining to the design process which forms the basis of this study. There seems to be scant research on teachers' involvement in the design process. What the literature survey shows is that there is more research undertaken regarding how children, rather than teachers, engage in the design-and-make process. I begin this chapter with product based conceptions of the design process and its challenges to raise my argument. Different aspects of the design process are discussed; viz, the definition of the phenomenon which aims to provide insight into what is meant by this design process as well as the nature of design problems. The review will explore related research focusing on students' technological practice. This chapter will also look at the influence of task structure on approaches to problem solving. This chapter will show the benefits of bringing design experts into the Technology classroom. Teachers' understanding of the design process in terms of subject matter and pedagogical knowledge will be discussed. The chapter will describe how to nurture 'designerly' thinking and design capabilities in primary school learners. Lastly this chapter will discuss knowing beyond how to make it work.

2.1 PRODUCT-BASED CONCEPTIONS OF THE DESIGN PROCESS AND ITS CHALLENGES

It is a well-established fact that creativity, critical thinking, and problem-solving capabilities and skills are key aspects of Technology Education (Gustafson & Rowell, 1998; Hill, 1998; Middleton, 2005; Mioduser & Dagan, 2007). According to Mioduser and Dagan (2007) the above capabilities and skills can be developed by providing students with authentic real-life problem contexts. Mioduser and Dagan (2007) further argue that in order for Technology students to develop these capabilities and skills, they need to engage with the design process. They also caution that teachers' conceptions of the design process might pose challenges in achieving this goal; on the one hand, the design process is thought of as a creative, branching, iterative and cyclical process reliant on multidisciplinary knowledge, and on the other it is perceived as a product-based process aimed at meeting the requirements of the Technology curriculum.

According to (Williams, 2000) the latter understanding of the design process has led to a common approach among teachers in the teaching of the design process in Technology Education. A series of steps are outlined by the teachers, viz. identify-design-make-appraise, and students are expected to follow them diligently in their projects. The ideology behind this systematic process, Williams argues, is that it can be taught. Learners who learn it can then apply it in different problem-solving contexts (Williams, 2000). This rigid procedure is inviting to teachers, because it provides a structure for the teaching of Technology.

Arguing along the same lines Mawson(2003) confirms that the rigid, linear approach to problem solving in Technology Education still dominates in schools. According to Mawson, teachers tend to structure designing activities as sequential rather than iterative. As a result, the emphasis on the linear model during Technology teaching and learning tends to change the design process into a series of products (Mawson, 2003). It is in this regard that Kimbel (as cited in Mawson, 2003) cautions against presentation of the design process as a simple, linear, systematic process. He likens the process of engaging in the design process to that of "constructing order from disorder". According to Kimbel, the complex and dynamic nature of the design process, which involves engagement in an iterative process, needs to be brought to the fore in the teaching and learning of Technology.

Presentation of the design process as a linear process has been criticised by a number of scholars (Anning, 1997; Fleer, McCormick et al., 1994). In fact, research indicates that neither students nor designers use a linear process or any predetermined process in their technological practice (Mawson, 2003). For example, McCormick et al.'s (1994) study, which focused on the nature of problem solving in Technology Education, found that students do not use a prescribed, linear process but follow a flexible approach during problem solving. However, when problem solving is conducted in the context of a test, the authors noted that students would rather use the teachers' approach in order to satisfy the assessment requirements

2.2 SO, WHAT IS A 'DESIGN PROCESS'?

The South African Curriculum and Assessment Policy Statement (CAPS) for Technology Grades 7-9 (Department of Basic Education, 2011, pp. 10-11), describes the ‘design process’ as a non-linear process used to develop solutions to problems, needs or wants. This process is the core of the subject which should be used to structure the delivery of all learning aims.

The Revised National Curriculum Statement (RNCS) defines the design process as: “A creative and interactive approach used to develop solutions to identified problems or human needs.” (Department of Education, 2002, p. 6).

Both curriculum statements identify the following five elements as constitutive of the design process: investigate, design, make, evaluate and communicate (Department of Education 2002, 2011). Although the elements of the design process are presented as discrete entities, the descriptions from both statements foreground the iterative nature of this process. Therefore it cannot be presented in a linear way as this would hinder the development of critical and creative thinking skills amongst learners when solving technological problems. Furthermore, teachers misconstrue the linear diagrammatic presentation of the design process in policy documents as how the process should occur. It is worth noting that in the assessment guidelines (p.15 n. d) for Technology intermediate and senior phase the written assessment for a project presents the tasks as isolated entities, therefore they are assessed as such which then results in assessing the end product. The Department of Basic Education (CAPS) (2011, p. 10) identifies problem solving using the design process as one of the key issue to teach in Technology Education. It is the design process which guides the problem solving. Therefore in Technology Education the term ‘design process’ is used interchangeably with that of ‘problem solving’. Mawson (2003, p.118) argues that these concepts are similar since they both have the same sequence of activities, namely, the inception of an idea, a reflection stage and evaluation of the success of the outcome.

According to McCormick (2004), problem solving and the design process are forms of knowledge about how to proceed when engaging in a technological process. According to the Department of Education (2002), the technological process and the design process are the activities that a learner engages in when identifying the need, investigating, and designing, making evaluating and communicating solutions. The processes students use to create solutions to technological problems are collectively referred to as the design process. In other words, the design process (technological process) describes all that should take place from the inception through development to the end of a technological activity (Pudi, 2007).

2.2.1 The nature of design problem

According to Lawson (2006) the design process is regarded as a complex process and this stems from its cyclical and iterative nature. Furthermore Lawson (2006) states that the process is not linear; possible solutions come from a complex interaction between parallel refinements of the design problem and ever changing design ideas. Design activities and learning offer students great opportunities to deal with complex design tasks within original/real and meaningful learning contexts (Kangas, Seitamaa-Hakkarainen, & Hakkarainen, 2011).

Different scholars argue that the design problems are characterized by being dynamic, genuine, ill-defined, and complex and require integration of knowledge across a sphere of knowledge (Cross, 2004; Hennessy & Murphy, 1999). According to Webber and Rittel (as cited in Kangas et al., 2011) design problems are “wicked problems” as they are difficult and puzzling since they are ill-formulated. There is no definite solution to a wicked problem. Kangas et al. (2011) state that design problems are conceptual artefacts guiding the design process, however they are likely to significantly change when the process progresses through successive iterative stages. They argue that designing is not just a practical activity which is simply putting conceptual ideas into practice. It is an iterative process which involves designing and constructing materially embodied artefacts, which includes a multi-method process. Conceptual, practical, and materially embodied activities cross-interact and support one another (Kangas et al., 2011, p. 2)

2.2.2 Technological practice

According to the nature of the design process there is a disjuncture in the way teachers approach the process as different scholars have argued above. Furthermore, research indicates that neither students nor designers use a linear process or any predetermined process in their technological practice. Different scholars define technological practice in different ways. Smits describe technological practice as:

> The way a person or group develops technological solutions. In industry how the initial problem is understood, the resources available and the knowledge and skills that developers have access to and value. In the school context children accomplish technological practice when producing technological solutions. This includes

> combining technological knowledge and comprehension of social issues together with practical skills to produce the technological solution. (Smits, 2000)

Moreland and Jones (1999) state that technological practice includes a knowledge base, how it is used, and the techniques associated with its practice. Willoughby (2004) describes technological practice as all operations, activities, phenomena that involve technology. In the following section a few key studies are reviewed with regards to children's technological practice.

2.2.3 On characterising children's technological practice

Gustafson and Rowell's (1998) study focused on 336 elementary school children's responses to an Awareness of Technology Survey questionnaire. The study explored how children propose to begin the technological problem-solving process. Survey responses were categorised into the following five types of beginnings:

- Guidance/direction beginning: Beginning with going to the resource centre to locate a useful book;
- Modelling/handling beginning: Beginning with making a model or with collecting materials;
- Imaging beginning: Beginning with designing a picture of a device;
- Social beginning: Beginning with communicating with peers about the device; and
- Reflecting beginning: Beginning with thinking about how the device is made. (Gustafson & Rowell, 1998, p. 158)

The above categories show that children began by seeking guidance from outside, others preferred starting by modelling or collecting materials and tools (handling), some would start by imaging, while others preferred social beginning (talking) and lastly some began by reflecting (thinking about how to make). The results showed that the first two types of beginning, i.e. *seeking guidance from outside sources* and *modelling/handling*, were the most popular choices selected. The third one, *imaging*, was less popular, while the fourth and fifth types of beginnings, *social beginning* and *reflecting,* were the least popular.

According to Gustafson and Rowell (1998) preference for some initial course of action is related to the children's perceptions of where useful ideas may lie. This, according to the authors, enables the children to 'figure out' a path forward that could lead to some problem solution. Children in lower grades showed an interest in starting problem solving by modelling/handling, and some children in all grades agreed with this initial course of action. It is, therefore, important for teachers to support children's efforts to begin and successfully complete tasks in design and technology. This implies that classroom teaching practices need to be flexible to allow children to implement the planning style which they perceive to suit the problem context. Gustafson and Rowell (1998, p. 160) believe that their study lends support to the idea that children can reveal spontaneous planning behaviour and are capable of using diverse planning strategies to begin problem solving. Gustafson's study alludes to the iterative nature of the design process. It is therefore crucial that teachers do not present the process in a linear method as this can hinder the development of children's creativity and critical thinking.

A study by Roden (1999) investigated how children's problem-solving strategies develop in key stage 1 (their first three years of schooling). Children were observed through reception year, year 1 and year 2 while engaged in a variety of design and technology tasks. A taxonomy of 11 problem-solving strategies emerged;

1. **Personalisation:** Children sought to relate the task to themselves and to past personal experience of a similar nature;
2. **Identification of wants and needs:** Children chose tools and materials, requested individual or co-cooperative working arrangements and different contexts in terms of space or time;
3. **Negotiating and reposing to the task:** They tested the boundaries of the task and what was allowed within the classroom culture. Through negotiation they change or repose the task to suit themselves;
4. **Focusing on the task or on tools and materials:** Interpretation of the task as well as questioning and discussion takes place. Clarification takes place of needs to be done and how tools and resources might be used;
5. **Practising and planning through playing with tools and materials**: Children wanted to gain experience of working with certain tools and materials;
6. **Identifying difficulties:** They began to pinpoint predicaments with the resources, in sharing or working alone, or in the constraints of time or space;
7. **Talking self through problems**: Children externalised their thinking;
8. **Tackling obstacles:** Children became aware of certain constraints and used different ways to overcome them;

9. **Sharing and co-operating:** They gave advice and assistance to their peers, using their experience of problem solving;
10. **Panicking or persisting:** Panic or slow persistence were routes used by children when realising that the lesson came to an end and they had to produce a finished product; and
11. **Showing and evaluating of work done:** These were used to consider progress, and inspire new and fresh ideas. (Roden, 1999, p. 23)

Roden (1999) observed that children at key stage 1 used the same taxonomy of strategies however; these were used differently at different ages. According to Roden (1999) an image of strategy variation emerged as children grew older, variation in children's problem-solving strategies over key stage 1 showing that strategies 3, 9 and 11 changed in nature with age, while strategies 1 and 7, i.e. personalisation and talking to self, declined with age. Furthermore Roden (1999) states that strategies 2, 4, 6 and 8 became more elaborate as children moved towards year 2 of key stage 1. The children demonstrated that they reflect on previous experiences and the knowledge is extended in terms of the complexity of the process. Strategy 10, panic or persistence, remained unchanged with age, whilst strategy 5, practising and planning, emerged from play, providing an opportunity for situated learning while reflecting on action. What remains a mystery is whether there is a relationship between strategy use and age or whether other factors influence children's strategies. The findings of Roden's (1999) study elucidate that as children grow older their knowledge base develops through experience. The finding also highlight that understanding of the design process requires acknowledging its iterative nature.

2.2.4 Approaches to tasks

In addition to research that focused on students' technological practices, some scholars (particularly in the Science Education field) have explored the influence of task structure on students' learning processes. McGregor (2008) carried out a study in which she examined the impact of task structure on students' learning processes in the context of several case studies on secondary school science practical. The three levels of differentiated task structure investigated were open task structure, partially structured task, and prescriptive task structure. According to McGregor (2008), in open task structure the problem is less clearly defined and methods are less clearly prescribed in the instruction sheet, which leads to a wide range of outcomes. Partially structured tasks, according to McGregor (2008), provide some scaffolding, while in-task guidance in the form of questions directed students' attention to important parts of the scientific method and the meaning of data collected. However, the prescriptive task provided all the practical steps critical to reaching a solution to the problem posed. This prescriptive method reduces opportunities for autonomous decision making around practical procedures (McGregor, 2008).

The findings of the case study indicate that task structure can have an effect on the naturalness and level of social interaction when students work collaboratively (McGregor, 2008). This shows that in order to develop creativity and critical thinking among students, teachers should be conscious of how they structure problem-solving tasks. Anderson (as cited in McGregor, 2008) emphasised that within an open problem-solving situation, students should be given support to attend to issues such as techniques, observations, patterns and explanations to make sense of everything in the process. Reis (as cited in McGregor, 2008) further explains that the problem-solving issues mentioned above are resolvable through appropriate scaffolding that guides students without directing routes to solutions. The study also revealed that prescriptive tasks appear to inhibit opportunities for engagement in procedural aspects of practical work.

In addition, McGregor's (2008) study revealed that scaffolding tends to occupy students more deeply with the ways of thinking about the task, and enabled development of both creative and critical thinking. Creative thinking was developed in a way that students were able to use a variety of problem-solving strategies, while critical thinking was developed in a way that students effectively evaluated procedures that influenced their findings.

Finally, from the schools observed it was noted that there was little or no culture of students readily questioning each other's ideas (McGregor, 2008). In order to achieve group discussion and interaction that supports cognitive development, putting thoughts into words is required during the whole process (McGregor, 2008). Posing questions, according to McGregor (2008), can sharpen the focus of students' attention on difficult issues. McGregor (2008, p. 536) states that "it is important that teachers guide the focus of attention of students, with the intention of exploring plausible subjective perspective at pertinent junctures, to nurture cognitive development through social interaction during problem solving processes". From this study it is clear that teachers should play an important role as facilitators of learning, guiding students throughout the process of problem solving and avoid being prescriptive.

This study signifies that guidance develops cognitive skills of students and meaningful learning takes place as there is a co-construction of knowledge. It is also worth noting that the interaction between students and teachers promotes reflection about decisions made to reach solutions. All the factors that the study signifies above are important in Technology education.

Closely associated to the above research is the work in Technology Education by Mioduser and Dagan (2007). They explored the relationship among alternative approaches towards design teaching, students' mental modelling of the design process and the quality of their solution to a design task. These approaches towards design teaching included structural and functional methodologies. The structural approach foregrounds the systematic learning of the stages of the design process, emphasizing learning of the design process stages in a sequential manner. The functional approach stresses the teaching and study of design functions instead of stages, which means it should be holistic, flexible and cyclical.

Participants were 80 seventh graders divided into two groups who were taught a unit on technological problem solving using either approach during a semester. Students represented their perception of the design process before, during and after the design process of a technological solution. Once the results were analysed Mioduser and Dagan (2007) concluded that the functional approach towards design instruction was more effective than the traditional instructional approach. The reason for its effectiveness is that it supported the construction of holistic, flexible and effective models of the design process of technological solutions. Mioduser and Dagan (2007) claim that demanding that students actively revise their models at each and every stage and make decisions about the next step to be taken leads to learning being a highly constructivist process.

2.2.5 Benefits of including a professional design expert in a technology classroom

Kangas et al. (2011) explored the benefits of including a professional design expert in elementary students' collaborative design processes. The main aim was to involve students in imitating professional practices and constructing an in-depth understanding of the full holistic design process. Participants were 32 elementary (pre-primary) students interacting with the expert in various forms, namely, face-to-face whole class discussions, small team conversations and comments sharing through a Knowledge Forum Database. The focus was on the scaffolding activities of participating experts in order to enlighten the facilitation of design based activities. These scaffolding activities include specific strategies as shown below:

- **Providing the structure for the design task**: this involves focusing attention on the design need and identification of design constraints;
- **Supporting the externalisation and envisioning of the design ideas**: deals with providing professional terms for describing ideas, providing tools and materials for visualising ideas and demonstrating how to use sketches and artefacts for visualising;
- **Facilitating the elaboration:** Focusing on aspects that need elaboration, providing domain knowledge/language/tools to support elaboration and modelling alternative solutions; and
- **Supporting professional techniques of external representation:** guiding to use real measurements while prototyping/sketching, providing tools/materials for sketching.

The results showed that the design expertise demonstrated the ability to see patterns that make sense in abnormal, open-ended design problems of which was too much for learners. However, providing a framework for structuring complex tasks can be useful to learners (Kangas et al., 2011). The structure can be provided by identifying the design constrains as well as focusing attention on the needs related to the artefact. Through examination of existing products/artefact a design constraint can be developed.

According to Kangas et al. (2011) students found it easy to produce a variety of design ideas, however they grappled with externalising their ideas for reflection and evaluation. Students lacked the skill of externalising and objectifying their ideas verbally and visually, however, they had clarity of their design inside their heads. To visualise the artefact that is not yet existing posed challenges to students and called for social and physical scaffolding (Kangas et al., 2011). Scaffolding "is a process during which an expert supports learner accomplishment of a specific task or attainment of a specific goal" (Sharma & Hannafin, 2007, p. 28). Social scaffolding was provided through using professional terms for the description of ideas (Kangas et al., 2011).

Providing tools and materials for visualising ideas, demonstrating how to use sketches and artefacts for visualising was a way that the designer used physical scaffolding for helping students to externalise and visualise their design ideas (Kangas et al., 2011). According to Kangas et al. (2011) drawing attention to those aspects that required elaboration, providing domain knowledge, language and tools and modelling different solutions was a way that the designer facilitated the elaboration of students' design ideas. Quintana et al (as cited in Kangas et al., 2011) states that students' lack of knowledge of what is possible, relevant, and productive poses a challenge to expatiating the various aspects of designs. The support provided developed students elaboration of design ideas.

The results indicate that students found it difficult to decide on the correct dimensions for the product throughout the design process as they used freehand while sketching and prototyping (Kangas et al., 2011). Therefore, professional idea presentation was made easy by the designer during the process as guidance was provided to students to use real measurements whilst sketching, through the provision of tools, materials for drawing and constructing models and further providing hands-on support on tool handling and materials (Kangas et al., 2011). The study shows how students benefit when coached by a professional expert in design. This calls for support and training of teachers to be able to do coaching as designers do. Kangas et al. (2011) suggest that teacher competences can be complemented with co-teaching and community partnership as this will open up chances to gain full benefits, which design learning can provide as there will be knowledge distribution. The above studies discussed children's technological practice and how design experts can contribute in the collaborative teaching of the design process. This collaborative teaching enhances teachers' enactment of the design process.

2.2.6 Teachers' understanding and teaching of the design process

Hynes (2012) study investigated middle school teachers' understanding and teaching of the design process particularly in engineering focusing on the subject matter and pedagogical content knowledge. Videotaped classroom sessions and teacher interviews were used to collect data which was then analysed to understand the subject matter and pedagogical content knowledge that the teachers used to introduce the eight steps of the engineering design process. The Massachusetts Department of Education model of the engineering design process is as follows:

1) Identify the need or problem;
2) Research the need or problem;
3) Develop possible solution(s);
4) Select the best possible solution(s);
5) Construct a prototype;
6) Test and evaluate the solution(s);
7) Communicate the solution(s); and
8) Redesign.

This model has key features that are 'analysis-synthesis-evaluation' however more steps are included to highlight each feature (Hynes, 2012). Steps 1, 2 and 3 describe a process of analysis. Steps 4 and 5 a process of synthesizing while steps 6, 7 and 8 a process of evaluation. Hynes (2012) states that when it comes to subject matter knowledge teachers need an understanding of the engineering design process (EDP). He argues that by not having a thorough understanding of the EDP teachers may be prompted to simply relay the steps of the process to their students, without providing detailed explanations of the aim and rationale of the steps.

McCormick (2004) attests to the above statement stating that Design and Technology teachers in the UK tend to reduce problem solving to a procedure that students 'had' to do. Hynes (2012) further states that it is important that students have a good understanding of the iterative process of engineering design and not just memorise the steps of the process. With regards to pedagogical content knowledge (PCK) relating to EDP, Hynes (2012) argues that knowing the subject matter one has to teach does not prepare one to teach the subject. Pedagogical content knowledge as different scholars (Hynes, 2012, p. 349) describe it is "knowledge that involves knowledge of students' abilities and conceptions, real world examples that tally concepts to students' lives, strategies that facilitates and deepen students' understanding and lesson management". According to Shulman (1987), PCK represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction. Harris, Mishra, and Koehler (2009) describe pedagogical knowledge as an in-depth knowledge that includes educational objectives, purposes values, strategies and more. Whereas Haynes describes content knowledge as knowledge about subject matter that is to be learned and taught.

2.2.7 Nurturing designerly thinking and design capabilities

Hynes' (2012) study included middle school teachers teaching fifth, sixth, seventh and eighth grade (ages 10-14). They were also teaching a range of subjects. The teachers were rated using a rating scale of low, medium, and high which was a rating for their explanation of the eight stages of the design process. The totals in the table for rating showed patterns where teachers as a group demonstrated their poor /strong understandings of the eight steps. From the results teachers achieved a high rating for step 5 (i.e. construct a prototype). According to Hynes (2012) teachers demonstrated an ability to engage students in a detailed discussion of prototypes and the reason why engineers use them. Teachers were also able to use relevant examples as well as synonyms to enable students to better understand the process. The study showed that teachers received a mix of medium and high ratings for step 8 (redesign). According to Hynes (2012) the step of redesign is very important for teachers to understand as students need to learn from trial and error.

Hynes (2012) classified the participants' (teachers) explanations into in situ explanations, review and advanced explanations. Hynes (2012) describes an in situ explanation as one whereby teachers offer some explanation of redesign while students are constructing their product. Review explanations are where teachers examined the redesigning the students did. Advanced explanation consists of interpretations of redesign that are multiple iterations and multiple versions. The multiple iterations describes the idea that during the design of an artefact the designer might critique earlier steps of the design process as they identify new needs or problems. Multiple versions refer to the idea that when an artefact has been considered complete the designer may go back and redesign for improvement for the next version (Hynes, 2012).

Hynes (2012) concluded that teachers displayed mixed levels of subject matter knowledge of EDP although they excelled in two stages regarded as critical by the investigator. With regards to pedagogical content knowledge teachers demonstrated an ability to use examples that students can relate to and were able to identify behaviours and patterns which they were able to tackle. This study shows that design processes are context based and that it is vital for teachers to have an in-depth understanding of the design process as well as pedagogical knowledge. This understanding motivates students, develops creativity, decision making and problem solving.

Milne's (2013) study indicates that primary teachers grapple with Technological knowledge and skills of how to communicate design ideas. In addition, young children experience challenges when involved in some elements of design as they tend to see design planning as an end product in itself instead of seeing that it has links to a process. Milne's (2013) study on how to nurture the 'designerly thinking' and 'design capabilities' in the new entrant classroom shows that teaching technology to young children is achievable. Milne puts forward strategies that allow students to achieve their goals while at the same time obtaining a clear understanding of the technological process. Milne (2013) describes young children's design thinking as well as their design capabilities very broadly. According to Coghill (1989) design occurs when a person acts with a purpose upon materials and objects, or has a plan and opinion about action. Coghill further states that design starts by making and playing when young students practice life skills and learn by doing. Milne (2013) argues that the activities should be owned by students rather than a supervisor. According to Milne (2013) when children move from early childhood education into formal school environment a problem arises as the teaching and learning goals is guided by the achievement of goals of the curriculum. Due to the challenge of achieving teaching and learning goals teachers find it difficult to teach the design process in a functional way as teaching is guided by the curriculum goals. Curriculums underplay the complexities of the design process. Teachers tend to see the design process as a sequence of steps thus they teach and assess as such. This shows the disjuncture between theory and practice. In addition teacher's select design briefs which are artificial and irrelevant to the students' world.

Multi curricula demands which disturb the truly child-centred approach, and which are contradictory to children's early childhood and home experiences are problematic (Milne, 2013). This calls for teachers to acknowledge that technological activities are context based. According to Milne and Edwards (2013) young children come to school with a variety of ideas that could be regarded as technological knowledge. In addition research has shown that they have a potential for making links in explaining new situation by referring to previous experiences and household “funds of knowledge” (Milne & Edwards, 2013). With regards to design capabilities Milne (2013) describes a number of factors which impact on young students’ ability to graphically represent their ideas within the design process. According to Milne (2013) young students drawing ability varies. During the planning stage within the design process 2D is problematic as young students find it difficult to convert 3D objects into a 2D representation without having a concise picture of the end product in their head. According to Golomb (2003) students are aware of the difference between 2D and 3D images and artefacts however they fail to draw in 3D. In addition to that they grapple to make connections between the two drawings which may be the reason why teachers complain that students do not stick to their plan during the making stage.

Hope (2009) states that factual knowledge has a strong influence on how a child tackles practical design tasks. Children need to see its relevance to the task. Golomb (2003) suggests that a flexible 3D medium can be used to effectively communicate ideas. Milne (2013) reiterates that hands on sensory experiences are valuable therefore inventive design behaviour can be developed through playing and experimentation with materials before children construct their ideas. This has implications for a technology teacher in a new entrant classroom. According to Milne’s (2013) study consideration needs to be given to planning and implementation of design tasks so as to improve young children’s’ designerly thinking.

Milne (2013) describes how teachers were able to plan and manage design tasks successfully. At the core of this success was that students were given support in acquiring understanding of the whole task. Scaffolding provided ease of connection between stages of planning to the students’ final product. Another feature of success was to contextualise the activity in children’s everyday lives thus making the task authentic which improved confidence, motivation and learning. Clear learning intentions were indicated from the beginning which enabled both the teacher and learner to understand the technological activity. Recapping, reviewing and restating enabled students to carry over information from different stages in the process.

Finally, Milne (2013) states that recurring interactions at all stages of the process help the teacher to be in contact with students allowing for intervention where necessary. Students’ design thinking and capability were analysed against the teacher’s planning framework. The framework consisted of conceptual learning which relates to understanding of technological concepts. Results indicated that eight out of ten students demonstrated a clear understanding of the purpose and function of the product (Milne, 2013). With regard to procedural learning which relates to how to do something, what to do and when to do it students demonstrated an ability to assess existing products so that they can make decisions about the new product. Furthermore there was evidence of reflective behaviour (Milne, 2013). Technical learning refers to skills related to manual and practical techniques which all students were able to demonstrate as they drew 2D plan to communicate their ideas. In addition it was evident that they adhered to their plans during construction of the product (Milne, 2013). Finally societal learning refers to concepts and ideas that show inter-connectedness between technology and groups of people.

Results showed that all students had clear societal understandings (Milne, 2013). In conclusion Milne (2013) highlights that the findings from the study indicate that it is achievable to teach technology in a new entrant classroom. Firstly students' designerly thinking can be enhanced if teachers consider focused but minimal structured practices of early childhood. Secondly keeping the teaching focus clear and simple with fewer variables and tasks that are connected to students' lives. Thirdly introducing drawn plans as a strategy to develop student in thinking about their product design. From Milne's study it is evident that design capabilities are linked to the interaction between mind and hand which equips students to be creative thinkers and problem solvers. This enables students to be functional in a society.

2.2.8 What is the role of Technology Education?

Hope (2009) argues that Technology education should not be seen as something that only prepares people for the world of work; it should be viewed as preparing for full functionality in human society. In addition Hope (2009) states that the design capability is close to what it is to be human. She further argues that to be fully human does not mean one has technical competences of making things, knowing that and know how does not fully describe technological capabilities. There are dividing characteristics that separate modern humans from other species that are related to design capability (Hope, 2009). Renfrew (as cited in Hope, 2009) states that the mutual interaction between mind and hand describes technological action which was a fundamental motive within human evolution. In order to have a clear understanding of the nature of human design capability Hope (2009) devised a tentative taxonomy of generic human capacities. These are:

- **Agency and connotation**

These include terms such as sentience, self-awareness and evaluative capabilities which all relate to meta-cognition. According to Hope (2009) it is this ability to "classify and reflect on the success of one's own and other peoples' thoughts, ideas and designs. It depends on the awareness of one's self as an agent who can plan, decide and effect changes in the environment, whether physical, social or cognitive."

- **Symbolism**

Hope (2009) describes language in different contexts as the only human representation reference system that allows one to think, imagine and design. She further states that this representation enables humans to understand the world and convey ideas to others. In addition Hope (2009) notes that language is an important factor in design.

- **Systems**

Human technological activity includes the ability to interpret the design task in terms of its purpose and the processes involved in making (Hope, 2009). Essential to this is analysis and synthesis, the capability to mentally dismantle things and reconstruct something new (Hope, 2009). Being systematic not only means to be organised – one must be able to reflect, evaluate and ascertain the changing product in the mind's eye.

- **Paracosm**

According to Hope paracosm is the ability to fantasize and be imaginative.

- **Rationality**

Hope describes rationality faculties as something that enables one to foresee possibilities and impossibilities. She adds that it is experience that enables one to compare and judge if an idea holds an internal logic, and age goes with experience

- **Creativity**

Hope states that "creativity comes through the bisociation of the rational and the divergent. It is the application of reason to possibility that turns divergence into creativity, the crazy idea into a plausible design." Hope's study is significant in the way in which it raises awareness in technology teachers of the capacities that they should seek to develop in learners. In addition these capacities can also be used in assessing capability tasks. (Hope, 2009, p. 52)

2.3 THEORETICAL FRAMEWORK

It is important that teachers have an understanding of the nature of learning that occurs when learners engage in a design task. Situated learning as a social learning theory was introduced by Lave and Wenger (1991) and will be used to better understand learning and learning through design. Lave and Wenger (1991) argue that learning as it normally occurs is a function of the activity, context and culture in which it takes place. This means that it is situated in and has defining characteristics of a process called 'legitimate peripheral participation', where learners participate in communities of practitioners moving toward full participation in the socio-cultural practices of a community (Lave & Wenger, 1991, p. 31).

In considering Technology Education as a community of practice, underlying principles emerge. Firstly, learning is understood as a social process which involves co-construction of meaning through active participation and shared understandings. It is the creation of an individual's identity which is formed by participating in a technological design activity in association with others that constitutes learning (Lave & Wenger, 1991). Secondly, learning through a design process is enhanced by the creation of authentic learning experiences which have some value and meaning for the learner (Lave & Wenger, 1991). This involves extending the learning experience beyond the Technology classroom setting into a wider community. In order to provide authentic learning experiences Herrington and Oliver (1995) propose a model of instruction based on situated learning which can be used in the design of learning environments:

- Provide authentic context: Context should reflect the way knowledge will be used in real life including the complexity of the real world situation, providing purpose and the possibility for extended exploration.
- Provide authentic activities: Activities should demand that learners 'find' and 'solve' problems inherent in the situation and determine how they will accomplish the task.
- Provide access to expert performances and modelling of processes: allow for the accumulation of narratives and strategies that use the social environment as a resource.
- Provide multiple roles and perspectives: Providing the learner with multiple opportunities to engage in an activity from differing perspectives will reveal different aspects of the situation.

- Support collaborative construction of knowledge: Activities should encourage collaborative searches for suggestions and solution to promote critical thinking.
- Provide coaching and scaffolding at critical times: the learning environment should be available to intercept and offer hints and strategies when learners are unable to progress in the task. In order to promote the type of learning mentioned above practice need to be explored Promote reflection to enable abstractions to be formed.
- Promote articulation to enable tacit knowledge to be made explicit.
- Provide for integrated assessment of learning within the tasks. (Herrington & Oliver, 1995, p. 25)

Situated learning is not possible without some degree of reflective practice. According to Waks (2001), Dewey and Schön propose theories of reflective practice as substitutes for the positivist model of 'reflection as technical rationality'. Although both theorists share the same sentiments regarding technical rationality they differ on how reflective practice is learned and what it is. Dewey shares with the positivists a commitment to science as a method of reflection meaning that it is applied science learned by doing; however, he rejects technical rationalism as it fails to provide independent check in ordinary experience outside the science context. Schön on the other hand states that the model of technical rationality fails to account for practical competence in divergent situations. Schön (1987) notes that practice is characterized by uncertainty, uniqueness and value conflict. Practitioners that are bound by positivist epistemology find themselves caught in a dilemma (Schön, 1987). Their definition of rigorous professional knowledge excludes phenomena that they have come to see as central to their practice (Waks, 2001). Schön (1987) sets out an alternative epistemology of learning in practice, to acquire professional knowledge from tradition and experience rather than from science. For Schön reflective practice is the forms of thinking specific to professional practices and it is learned in the thick of professional activity. Schön's idea of reflection in teaching practice stresses the importance of bringing to the conscious level those practices that are tacit. In fact teachers always function from a theoretical foundation; bringing tacit knowledge to the surface allows the beliefs to be examined. As teachers reflect in and on their practice, a growth spiral becomes obvious. The initial reflection phase results in change of action, which then necessitates another reflection (Schön, 1983). Dewey accords with Schön's statement that reflection may be thought of as a cyclical process Therefore reflection thus increases knowledge and increased knowledge develops one as a teacher. For this study Schön's idea of reflection will be used.

Schön identifies two types of reflection: 'reflection-in-action' and 'reflection-on-action' (Schön, 1987). Schön argues that practice is a knowledge affair. Reflection-in-action is where one reflects on actions during the event. According to Schön (1987) practitioners apply knowledge in action when facing a situation and the situation starts to 'talk back' by denying or confirming the suggested framing. Practitioners do not take time out to reflect and nor do they use scientific enquiry (Waks, 2001). Instead, Waks argues, they reflect in action using language that is particular to the practice.

In contrast reflection-on-action takes place after action has occurred. According to Schön (1987) reflection-on-action is a process of thinking back on what has been done to discover how knowing in action may have contributed to an unexpected outcome. Therefore reflection on past action shapes future actions.

2.3.1 Design process as reflection in action

As a philosopher in design and being a design educator, Schön came up with ideas of how design should be taught and learned (Waks, 2001). Schön (as cited inWaks, 1999; Waks, 2001) sees design as a process of trying out meaning through practical moves. Such a meaning of design has three implications:

1. To learn design is only possible by going through the practical operations of frame experimentation, because design is not didactically or discursively teachable.
2. It is holistic, so the parts cannot be learned in isolation because to design is to work towards a pattern, a world of meaning comprising all components of a situation.
3. It depends upon the ability to recognise desirable and undesirable qualities of the discovered world.
4. Designing is a creative process. A designer's reflective conversation with the materials of a situation can result in new discoveries, meanings, and inventions. (Waks, 2001)

Schön's (1987) ideas about teaching and learning to design follow closely from the conception of the design process above. Therefore, design teachers play an important role as coaches to teach knowledge and reflection, the following tasks of coaching are key:

- Firstly, when dealing with a design problem one needs to do this alongside the novice via combinations of moves and words, demonstrations and descriptions, so that novices have the ability to deal with similar situations;
- Secondly, when translating the languages of the demonstrations and descriptions into the language of the novice learner, metaphors should be used; and
- Lastly, establishing a good relationship between learner and coach is important.

Practitioners' reflection plays an important role in the process of solving design problems. (Waks, 2001).

2.3.2 The role of reflection in solving design problems

Research indicates three reasons which illustrate the importance of reflective thinking in a design process (Adams, Turns, & Atman, 2003; Rowland, 1993; Schön, 1983).

- **Controlling the design process**

According to Rowland (as cited in Hong & Choi, 2011) designers reflections enable designers to be mindful of their decisions in a design process. Furthermore according to Lloyd and Scott (1994) designers' reflection includes them in constantly observing, assessing, and adjusting their understanding of the problems and the generation of possible solutions. Therefore designers are able to control their design process and derive appropriate strategies for their next move through reflection (Rowland, 1993).

- **Handling new design problems**

Most design problems are context based and domain specific (Jonassen, 2011). Through reflection designers are able to invent, test strategies and improvise. Therefore, when faced with new design problems, reflective designers will be able to succeed when their reflection leads them beyond their experience (Hong & Choi, 2011).

- **Increasing the frequency of iterations**

Reflective thinking helps designers to increase the number of iterations during the design process. The designers are able to actively engage in reflection where they evaluate the meaning of problem repetitively so they can reshape the appropriate problem space and carefully re-examine their proposed solutions (Adams, 2001). This coincides with Schön's idea of situation talk back.

To conclude, scholars emphasise the key role of reflection in improving understanding and achieving high quality design problem skills.

2.4 CONCLUSION

This chapter foregrounded the importance of understanding the design process as well as the approaches that should be applied in teaching and learning of Technology Education. The approaches and understanding of the design process develops the critical and creativity skills that enable children to be functional in society. In addition situated learning and reflection in and on action theory was used as a lens for describing the practitioners' understanding of the design process. The following chapter focuses on the research methodology.

CHAPTER 3: METHODOLOGY

Chapter 3 aims to describe the methodology and the design of this study. This will be accomplished by discussing the case study method and the purposive sampling method. The appropriateness of instruments used for data collection in the three parts of the study as well as data analysis is discussed in the research design. Issues of validity, ethics and limitations which had to be taken into consideration are also discussed.

3.1 WHAT IS A CASE STUDY?

Bassey (1999) talks about two types of research in education. Firstly, the educational case study which he refers to as a critical investigation with a purpose of informing educational judgements and decisions aimed at improving educational action. Secondly, discipline research in education which is a critical inquiry that informs understandings of phenomena (in educational settings) which are related to the discipline. This study will cover both types in that it is a case study that focuses on ACE technology lecturers' and in-service teachers' understandings of the design process. In this section, I discuss what a case study is.

According to Yin (2009) case study research entails a thorough enquiry with a large amount of information about a case(s) and context in a particular period of time. As a research method it is used in various circumstances to serve the purpose of contributing to our knowledge of individual, group, organisational, political and related phenomena (Yin, 2009). There are different descriptions as well as different purposes of a case study. Yin (2009) describes a case study as an empirical inquiry that relies on multiple sources of data to investigate a contemporary phenomenon within its real life context, when the boundaries between phenomenon and context are not clearly evident. In this regard Yin (2009) identifies the following three types of case studies:

- **Exploratory case studies**
  These studies aim at defining the questions and hypothesis of a subsequent study.

- **Explanatory or causal case studies**
  These aim to explain data bearing cause-effect relationships explaining how events happened.

- **Descriptive case studies**

  These aim to provide a complete description of a phenomenon within its context.

Bassey (1999) brings forth a further classification dimension to educational case studies by highlighting the following three categories:

- **Theory-seeking and theory-testing case studies**

  These are particular studies of general issues, which means a case is instrumental in order to understand a broader issue.

- **Storytelling and picture drawing case studies**

  These are analytical accounts of educational events, projects programmes institutions or systems with the purpose of providing theoretical insights.

- **Evaluative case studies**

  These case studies aim to enquire about an educational programme, system, project or event in order to assess their worthwhileness. (Bassey, 1999, p.62)

Despite the differences with regards to the angle taken and the terminology used in the categorization of the different types of case studies by the above mentioned two scholars, one notes significant commonalities between the two. Yin's (2009) classification of exploratory case study accords with Bassey's (1999) theory seeking case study. They both point to the fact that the focus is more on the issue rather than the case as such. In addition Yin's (2009) explanatory case study could be related to the category of theory testing as described by Bassey (1999). These types of case studies try to describe and explain issues as they are happening without making value judgements. Furthermore, descriptive case study classification by Yin (2009) corresponds to Bassey's (1999) storytelling and picture drawing case study category. These types aim to achieve a comprehensive understanding of a case with the aim of illuminating theory.

From these categories this study could be described as a descriptive case study as Yin states that such a study presents a complete description of a phenomenon within its context. This study seeks to describe in depth ACE Technology lectures' and teachers' understanding of the design process within their context.

The issue of generalization in case study has been a general concern (Yin, 2009). Commonly used forms of generalization are identified by different scholars, namely, statistical generalization and analytical generalization (Bassey, 1999; Swanborn, 2010; Yin, 2009). Yin (2009) argues that statistical generalization is unsuitable for a case study. He states that in statistical generalization an inference is made about a population (or universe) on the basis of empirical data collected about a sample from that universe. However, in analytic generalization the concern is not so much for representative samples so much as its ability to contribute to theory generation (Bassey, 1999; Yin, 2009). Different scholars attest to Yin's argument that generalizations from cases are not statistical but are analytical (Bassey, 1999; Cohen, Manion, & Morrison, 2011; Johansson, 2003; Darke, Shanks, & Broadbent, 1998). Johansson (2003) further mentions that analytical generalizations are based on three principles of reasoning, namely, deductive, inductive and abductive. These principles can be used as a combination or individually.

When generalization foregrounds the deductive principle the procedure resembles that of an experiment whereby a hypothesis is formulated and testable consequences are derived by deduction. Comparing expected findings deduced from a theory and a case with empirical findings it is possible to verify or falsify the theory (Johansson, 2003).

The second principle is through induction which is accomplished through inductive theory-generation, or conceptualization which is based on data from within a case. The result of this is a theory which normally consists of a set of related concepts (Johansson, 2003).

The third principle of generalization is abduction which is a process of facing an unexpected fact by applying a rule (known or created for the occasion) and as a result positing a case that may be (Johansson, 2003).

Based on the principles mentioned above this study foregrounded the deductive principle as it is guided by the theoretical framework of situated learning and design.

3.2 RESEARCH PARTICIPANTS – SAMPLING

Sampling involves making decisions about what people, settings and behaviours to observe. According to Cohen et al. (2011), the quality of a research study is not only determined by appropriate use of methodology and instruments but also by the suitability of the sampling strategy chosen. Qualitative researchers usually study a small number of individuals or situations and they retain the individuality of each of these in their analyses. This allows the researcher to understand how events, actions and meaning are shaped by the unique circumstances in which they occur (Maxwell, 2005). For this study non-random sampling was used since the study did not intend to generalise and represent its findings beyond the sample in question (Cohen et al., 2011). In a non-probability sample some members of the wider population definitely will be excluded and others definitely included;

in other words, every member of the wider population does not have an equal chance of being included in the sample (Cohen et al., 2011).

In essence the study used purposive sampling, where, according Cohen et al. (2011), the sample is used in order to access those who have experience and can provide the best information to achieve the objectives of the study. Data for the research was collected during the second semester of 2012 and 2013 at the University of KwaZulu-Natal, Edgewood Campus. Participants chosen for the study were ACE Technology lecturers at the University of KwaZulu-Natal and in-service teachers who have experience in Technology education. The reasons for choosing this sample were twofold: in terms of access, it was easy to reach the participants; and in terms of experience, the participants that were involved were seasoned teachers of Technology Education who foreground the notion of design in their teaching.

3.2.1 Description of the research participants

A total number of seven technology practitioners comprising two ACE 2 lectures and five teachers were recruited from different institutions. Out of the five teacherstwo were also tutors on the ACE programme. The participants were knowledgeable of what was to be investigated. By virtue of their profession participants were qualified in Technology Education and had all had been trained in Technology Education. Furthermore the participants had attended workshops and conferences in Technology Education. In addition to attending workshops their teaching experience in Technology Education makes a valuable contribution to the study. Two participants had teaching experience from intermediate phase up to higher education. Another two had experience in teaching Technology Education in both senior and higher levels. One out of the seven had teaching experience in the senior and intermediate phase. One participant taught in the intermediate and higher education. One participant had only higher education teaching experience.

3.3 RESEARCH DESIGN

The research design is a sequence of plan that links the empirical data to a study's initial research questions and finally to its conclusions (Yin, 2009). According to Creswell and Clark (2008) this sequence of plan refers to a procedure for collecting, analysing and reporting research. Yin (2009) argues that a research design is more than a work plan because its purpose is to prevent a situation where the results do not address the research questions.

This study as stated before was guided by the following two research questions:

1. *What are ACE Technology Education lecturers' and in-service teachers' understanding of the design process?*
2. *What informs and influences ACE Technology Education lecturers' and in-service teachers' understanding of the design process?*

The research design of the study as drawn from the instruments below was divided into two phases:

- Phase 1: Questionnaire to address Research question 1.
- Phase 2: First focus group interview to address Research question 1 and 2.
  Second focus group interview to address Research questions 1 and 2.

To answer the first research question, data was drawn from phases 1 and 2, using the following data sources:

- Semi-structured Questionnaire;
- Focus group interview 1 and 2 , which incorporated the following three parts:
  - Narratives;
  - Graphical representation / Models (Drawings); and
  - Participative engagement.

To answer the second research question, data was constituted from phases 1 and 2, using the following data sources:

- Focus group interview 1 – narrative part; and
- Focus group interview 2.

The above mentioned three parts are discussed in detail in the following sections.

3.3.1 Phase 1

Through the use of a semi-structured questionnaire (see Appendix C) this phase aimed at achieving two things:

- Obtaining the biographical data of the participants;
- Eliciting the participants' understanding of the design process.

According to Gray (2009), a questionnaire is an instrument through which participants are asked similar questions in a predetermined order. This study used a semi-structured questionnaire with open ended questions which allowed participants to respond in the way that they thought was best. This instrument was administered once, i.e. at the beginning of data collection and it was self-administered. In addition the questionnaire was hand delivered and collected later from the respondents.

The questionnaire consisted of six questions. The first five questions probed the participants' background and experience in the teaching of Technology by exploring items such as the participants' teaching experience, academic qualification, subject / content knowledge, informative workshops attended etc. The sixth question which directly addressed the first research question was posed as follows:

> ***Some technology teachers use the terms 'design process and' problem solving' interchangeably. What are your views on this?***

The participants were further asked to elaborate on their understanding of the design process in the context of the above question.

3.3.2 Phase 2

Using two focus group interviews this phase aimed to address both Research Question 1 and Research Question 2 (see Appendix D, Parts 1 & 2). According to Cohen and Manion (2011) focus group interviews are forms of interviews which are based on the interaction within a group discussing a topic supplied by the researcher yielding a collective rather than an individual view. In addition, Babbie and Mouton (2001) argue that focus group interviews serve to shape and reshape opinions about the topic at hand. In this study, two focus group interviews were used to 'shape and reshape' the ACE Technology lecturers' and teachers' understanding of the design process in order to arrive at an collective participative framework for understanding the design process. As argued by Lave and Wenger (1991), the creation of an individual's identity is formed by participating in an activity in association with others, which constitutes learning. In this regard, the participants were involved in participative engagement in order to reach a collaborative understanding of the design using literature. Situated learning as a conceptual framework was used in this study to give a better understanding of learning and learning through design. In considering the ACE Technology lecturers and in-service teachers involved in this study as a community of practice, learning within a community of practice as provided by the focus group interviews is thus understood as a social process which involves validation of ideas, co-construction of meaning through active participation and shared understandings. This process was enacted in three ways as shown in the three parts below.

3.3.2.1 Part 1: Validation of preliminary understandings of the design process through narrative

The aim of the first part was twofold:

- To validate the data gathered in the questionnaire;
- To validate the interpretation of the analysis done by me on the information gathered through the questionnaire.

The participants were assembled together in order for them to reflect on their understandings of the design process. For validation the findings were presented at an individual level using the following questions which guided the validation process:

- "Do you feel that the presentation captured your ideas adequately? Yes/No. Elaborate."
- "Do you agree with how your ideas were interpreted? Yes/No. Elaborate."

Participants had to confirm the interpretation and respond to queries that I had. The first focus group was divided into two parts. Part 1 focussed on the narrative aspect of the participants' understanding of the design process and what informs and influences it, addressing both research questions.(Appendix D).

3.3.2.2 Part 2: Validation of preliminary understandings of the design process through graphical representations

In addition to the narrative element, graphic representation was used aiming at eliciting the participants understanding of the design process. According to Crilly, Blackwell, and Clarkson (2006) diagrams are a powerful source of thought and a tool of worth in imparting thoughts to others. Diagrams ease the process of interview by providing a visual summary of concepts and relationships in focus. In addition graphic elicitation clarifies contributions of the interviewees that are difficult to verbalize clearly (Crilly et al., 2006).

3.3.2.3 Part 3: Co-construction of meaning of the design process through participative engagement

The aim of Part three was to use the literature and the ACE Technology lecturers' and teachers' understandings to come up with a collaborative understanding of the design process. Part three continued to address Research Question 1 as well as certain aspects of Research Question 2. The participants were assembled in order for them to reflect on their understandings of the design process. According to Schön (1987) reflective practice is a means of developing self-awareness about the nature and impact of one's performance as a practitioner, which creates a chance for professional growth. It is in this regard that a focus group interview was chosen, to allow space in which the participants get together to create meaning among themselves rather than individually (Babbie & Mouton, 2001). The focus group session lasted for four hours and was video recorded.

The table in (Appendix D) and the questions below guided the engagement:

- "What have you learnt from participating in this focus group?"
- "Do you still hold the same understanding of design process as you did when you answered the questionnaire? Yes/No. Elaborate."
- "Which frame reflects your understanding? Why?"
- "Which framework would you use in your own practice? Why?"

As can be seen from the above questions, they not only sought to explicate the changes in the participants' understanding of the design process but to also find out what informs and influences ACE Technology Education lecturers' and in-service teachers' understanding of the design process. In this regard, the participants were forced to establish an individual participative framework for their understanding of the design process.

3.4 DATA ANALYSIS

With regards to Research Questions 1 and 2 data was analysed according to the two phases of the research design of this study:

- Phase 1: Analysis of questionnaire to address Research Question 1;
- Phase 2: Analysis of first focus group to address Research Questions 1 and 2; and
- Analysis of the second focus group interview to address Research Questions 1 and 2.

3.4.1 Phase 1: Analysis of the categories of description of the relationship between the design process and problem solving as drawn from the questionnaire

To answer Research Question 1: *"What are ACE Technology Education lecturers' and in-service teachers' understanding of the design process"*, the two foci that emerged from the thematic analysis, namely, the relationship between the design process and problem solving, together with the definition of the design process, were used as a premise upon which the understandings of the design process were explored. This exploration was accomplished in three ways. First, by proving the analysis of the findings on the categories of description that emerged on the relationship between the design process and problem solving and an overall analysis of the findings at the individual and the supra level, as drawn from the two phases of the research design:

Phase 1: Semi-structured Questionnaire;

Phase 2: First focus group interview (narrative and graphical representations);
Second focus group interview (narrative).

Second, by presenting the analysis of the findings on the conceptions of the design process as drawn from the questionnaire, second focus group and an overall analysis on conception at a supra-individual level. Third, by presenting a meta-analysis of the above two analyses in order to give a global picture of the Technology Teachers' understanding of the design process.

The findings from the analysis of the questionnaire revealed two aspects that were being foregrounded by the participants:

- The relationship between the design process and problem solving.
- The definition of the above two concepts, i.e. the design process and problem solving (Appendix C1-8)

With regard to the relationship between the design process and problem solving the following three categories were established:

- The design process is not similar to problem solving.
- The design process is equated to problem solving.
- The design process is more than problem solving. (Appendix C1-8)

3.4.2 Phase 2 Part 1: Analysis of categories of the relationship between design process and problem solving through first focus group (narrative)

This part continued with thematic analysis after obtaining feedback from the participants' data which was then combined and classified to the patterns already identified in Phase 1. Analysis of Phase 2 as drawn from the focus group interview mainly focused on validating my interpretation of data and analysis as drawn from the questionnaire as well as elicitation of what informed and influenced the participants' understanding. Upon reflecting on the findings gathered from the questionnaire it emerged that participants foregrounded two categories as stated below with regards to the relationship between the design process and problem solving.

- The design process is not similar to problem solving.
- The design process is equated to problem solving. It is significant to note that this category ***did not feature*** in this first focus group discussion.
- The design process is more than problem solving. (Appendix C1-8)

3.4.3 Phase 2 Part 2: Analysis of categories of the relationship between design process and problem solving through first focus group (graphical representation)

Further to the narrative part, graphic representation was used aiming at eliciting the participants understanding of the relationship of the design process and problem solving. The findings revealed that participants still foregrounded the two categories as mentioned in the first focus group (narrative) analysis. Interestingly within the first category, variations were observed. Furthermore an additional category was established forming a fourth category.

3.4.4 Phase 2 Part 3: Overall analysis of the relationship between the design process and problem solving as drawn from the questionnaire, the first focus group interview and graphical representations

The summary of categories of findings at supra-individual level revealed that participants' understanding changed as they were reflecting and interacting within a community of practice. Initially participants had identified three categories; upon reflecting it changed to two categories (see 4.1.2.3) and finally a new category was introduced forming a fourth category in the last source of data.

The summary of categories of findings at an individual level also revealed changes that took place in participants' understanding through reflection-in-action and reflection-on-action from the three sources of data. Participants held different views which they qualified differently. Some participants understanding remained constant throughout the three sources of data.

3.4.5 Phase 1: Analysis of the conception of the design process through the questionnaire

In distinguishing between the DP and PS, the analysis reveals that the participants view problem solving as a general process whilst the design process is seen as a specific process. In terms of its specificity, the following five conceptions of design were elicited.

- Design process is action orientated.
- Design process is not linear therefore it is iterative.
- Design process is solution based.
- Design process is appraisal and evaluation.
- Design process is systematic (Appendix C1-8).

3.4.6 Phase 2: Analysis of the conception of the design process through the second focus group interview

It emerged that participants' conceptions of the design process broadened due to reflection and intervention through using literature. The participants' conception of the design revealed four themes:

- Design process is problem based.
- Design is complex process.
- Design is an iterative process.
- Design process is context based (Appendix D2).

3.4.7 Overall analysis of the conceptions of the design process as drawn from the questionnaire and the second focus group interview

The summary of conceptions of findings at supra-individual level revealed that conceptions 2 and 3 were common to both data sources. Two new conceptions were identified in the second data source, resulting in a total number of 7 conceptions in both phases, as illustrated below:

Conception 1: Design process is action orientated.

Conception 2: Design process is not linear, but iterative.

Conception 3: Design process is solution based.

Conception 4: Design process is appraisal and evaluation.

Conception 5: Design process is systematic.

Conception 6: Design process is complex.

Conception 7: Design process is context based.

3.4.8 Part 3: Meta-analysis of all the phases to provide a global picture of the Technology Teachers' understanding of the design process

In all the variations of understanding from the different instruments it was observed that the focus was on the distinct characteristic of the design. A global understanding of the design process emerged when looking at a cross analysis of instruments at a supra level. A common understanding was also reached that the design process can't be equated to problem solving.

3.4.9 Phase 2: Analysis of what informs and influences ACE Technology lecturers' and in-service teachers' understanding of the design process – first focus group interview

As mentioned earlier, Phase 2 aimed at answering Research Question 1 and Research Question 2. After reflection and probing in both focus group interviews aiming to answer Research Question 2: "what informs and influences ACE Technology lecturers' and teachers' understanding of the design process" two major influences emerged: the first influence seemed to be brought about the framework used in the study which is reflection in and on action within a community of practice. The second influence appeared to be brought about by the interface between understanding and practice. It would seem that this interface is premised upon two ideas:

- Understanding gets transformed during practice.
- Understanding gets confirmed during practice.

In this section I first discuss how reflecting within a community of practice influences understanding. Second, I discuss how the interface between understanding and practice influences understanding, using the two ideas mentioned above to map out analysis.

3.4.9.1 Part 1 – Analysis of how understanding is influenced by reflecting and interacting within a community of practice

The summary of categories of findings at an individual level also revealed changes that took place in participants' understanding through reflection-in-action and reflection-on-action from the three sources of data. From the beginning, five participants had the same understanding foregrounding that DP is equated to PS. Upon reflecting none of them identified with that idea. Furthermore a new category emerged through reflecting-on-action. Looking across the data sources it was observed that participants held different views which they qualified differently. Some participants understanding remained constant throughout the three sources of data.

3.4.9.2 Part 2: Conceptual changes observed as derived from the participants' understanding of the concept of the design process

The summary of the conceptual changes observed from the questionnaire and second focus group revealed conceptions which were common to both data sources. Two new conceptions came to the fore in the second data source indicating a richer level of understanding

3.4.10 Analysis of how understanding influenced by the interface between understanding and practice – how it gets transformed and confirmed in practice

In this part I discuss the influence of practice on understanding under the following two categories:

- Understanding gets transformed during practice.
- Understanding gets confirmed during practice.

3.4.10.1 Part 1: Eliciting what makes understanding to be transformed during practice – first focus group

With further reflection through the use of the first focus group interview it emerged that a disjuncture between theory and practice causes understanding to be transformed. Transformation of understanding relates to issues such as identity. Identity encapsulated the following: personality, teaching approach as well as academic reading and qualifications in design.

3.4.10.2 Part 2: Eliciting what enables understanding to be transformed during practice – second focus group

Further to expatiating the understanding of DP and DS, participants were involved in a participative engagement exercise which involved reviewing scholarly literature on the design process. Upon reciprocal reflection-in-action through intervention, level of learning was evident as described by Schön (1987). During the second focus group, through reflective dialogue, participants were asked to clarify what they meant by the following as was stated in Phase 1.

- Problem solving as a general process; and
- Design process as a specific process in an educational context.

They were taken back to the research question as posed in the questionnaire. This revealed the interface between practice and understanding that causes understanding to be transformed during practice. It emerged that contextual issues such as pedagogical and curricular aspects caused understanding to be transformed.

3.4.10.3 Part 3: Understanding is confirmed during practice – second focus group

Through participative engagement, reading and reflection-on-action it emerged that there seemed to be an alignment of the participants' previous understanding and how it will be enacted in classroom practice. When understanding is confirmed during practice it talks to issues of authenticity.

3.5 VALIDITY AND RELIABILITY

Validity and reliability are key aspects effecting research (Cohen et al., 2007). Reliability in a case aims to reduce errors and biases in a study (Yin, 2009). According to Yin (2009), a case study is said to be reliable if the same procedures are followed by different researchers conducting the same case study and arriving at the same findings and conclusions. In order to ensure reliability in this study all procedures were documented. Validity refers to the extent to which a specific measurement provides data that relates to commonly accepted meanings of a particular concept (Babbie & Mouton, 2001). There are several different types of validity, as outlined by Cohen et al. (2009): internal and external validity, construct and content validity. According to Yin (2009) internal validity only applies to explanatory or causal case studies and not descriptive or exploratory. As this is a descriptive study the focus was on construct and external validity. To ensure construct validity data collection methods were triangulated meaning multiple sources of evidence were used. All data collection instruments covered the area/concept that was being explored to ensure content validity. External validity was ensured by generalizing the results of the study using theory as a framework.

3.6 LIMITATION

A possible limitation of the study that was anticipated was if participants wished to withdraw from participating for any reason. If this was the case, then another practitioner within the same group will be given a chance to participate in the research. However most of the participants withdrew towards the end of data collection therefore four participants remained. In addition the sample used in the study was small and that limitation has an effect on generalising of data. However the sample was purposively selected and also conveniently chosen. Furthermore some participants behaved differently from normal, they were not as open as they should have been in engaging in the discussion. In order to normalise the situation the researcher gave participants an opportunity to write their responses on paper as well.

3.7 ETHICS

Rudestan and Newton (2001) argue that the key element of conducting ethical research involves obtaining informed consent from participants. Before the research process commenced, the researcher ensured that permission from all gatekeepers was sought. Furthermore, the research participants were given consent forms to complete to indicate that they agreed to be involved in the research process. According to O'Leary (2004) the concept of informed consent emphasises the importance of researchers accurately informing respondents and participants of the nature of their research. The participants were informed that participation was voluntary and that they may discontinue at any time should they wish to. Bassey (1999) calls this respect for democracy. Participants were assured of anonymity and confidentiality (Bassey, 1999).

3.8 CONCLUSION

This chapter has described the research methodology and the rationale for the choice of methods adopted in the study. The method of choosing a sample as well as description of the sample has been presented. A brief statement of what a research design is together with the instruments used for data collection was explained. The method used to analyse data was discussed. Issues of validity and reliability have been addressed. In the following chapter the data will be analysed and interpreted.

CHAPTER 4: PRESENTATION AND ANALYSIS OF RESEARCH QUESTION 1

This chapter aims to answer the Research Question 1: *What are ACE Technology Education lecturers' and in-service teachers' understanding of the design process?* To answer this question, the two foci that emerged from the thematic analysis, namely; the relationship between the design process and problem solving together with the definition of the design process are used as a premise upon which ACE Technology teachers' understanding of the design process is explored. This exploration is presented in three ways.

First, I present the analysis of the findings on the categories of description that emerged on the relationship between the design process and problem solving as drawn from the questionnaire and the first group interview – incorporating both the narrative and graphic representations. .

Second, I present the analysis of the findings on the conceptions of the design process as drawn from the questionnaire as well as the second focus groups.

Third, a meta-analysis of the above two analyses is presented in order to give a global picture of the Technology Teachers' understanding of the design process. I conclude the chapter by drawing attention to how collaborative reflection on action develops understanding.

4.1 ANALYSIS OF THE FINDINGS ON THE CATEGORIES OF DESCRIPTION OF THE RELATIONSHIP BETWEEN THE DESIGN PROCESS AND PROBLEM SOLVING AS DRAWN FROM THE QUESTIONNAIRE AND THE FIRST GROUP INTERVIEW

As mentioned in the introduction, the following two foci were brought to the fore:

- The relationship between the design process and problem solving. – Section 4.1.
- The definition of the design process – Section 4.2.

In the following sections, the above two foci are unpacked, respectively.

4.1.1 Exploration of the relationship between the design process and problem solving through the questionnaire

As mentioned in the previous chapter, the questionnaire contained questions that related to biographical data and one question that aimed to elicit the participants' understanding of the design process. In order to elicit the participants' understanding the following question was asked:

> *Some Technology Teachers use the terms 'design process' and 'problem solving' interchangeably. What are your views on this? Please elaborate on your understanding of the design process?*

With regard to the relationship between the design process and problem solving, the following three categories came to the fore:

- Category 1: the design process is not similar to problem solving.
- Category 2: the design process is equated to problem solving.
- Category 3: the design process is more than problem solving (Appendix C1-8).

<u>Category 1: the design process is not similar to problem solving</u>

This view was held by one out of the seven participants in the study, as illustrated in the following excerpt:

> ***P2:*** *Problem solving and design process should not be used interchangeably.*
>
> (Appendix C2, R1)

In the above excerpt P2 clearly indicates that the design process and problem solving should not be used interchangeably as they are not synonymous.

<u>Category 2: the design process is equated to problem solving</u>

Five out of the seven participants view the design process as being similar to problem solving.

> ***P1:*** *In the essence, design process is a process of finding a solution to a need. Therefore it is in a way problem solving.* (Appendix C1, R1)

P3: *Design processes are stages followed through problem solving. Design process involves the five stages that is investigation, design, make evaluate communicate.* (Appendix C3, R2)

P4: *There is a thin line that separates the two but design process comes as a result of intervention in looking for a solution to a problem. Teachers use steps for design process in problem solving without considering them as a suggested process to follow.* (Appendix C4, R1-3)

P5: *Formation of a plan to help designer to devise a solution.* (Appendix C5, R1*)*

P7: *Design process is an approach to solve a problem. It is a way used by technologist/designers to tackle a problem and look for solutions.* (Appendix C7, R1)

With regard to the above category the design process is equated to problem solving as it is a tool used to solve a problem or to find a solution.

<u>Category 3: the design process is more than problem solving</u>

Two out of the seven participants held the idea of the design process being more than problem solving:

P1: *The design process is much more than just merely solving a problem. It is a systematic process during which a problem is solved.* (Appendix C1)

P6: *To me the design process is much more than problem solving. It is used to encapsulate the actions taken by the technologist/learner to design and make an artefact to meet a need or want, as it incorporates many diverse actions.* (Appendix C6, R1-3)

The views above indicate that the design process is not just about solving a problem but it is more than that as there are different activities or actions that must be carried out in order to satisfy a need or want.

4.1.2 Exploration of the relationship between the design process and problem solving through focus group 1

4.1.2.1 Narrative representation

As participants reflected in a collaborative manner it emerged that in this first focus group interview only two categories came to the fore in contrast to the findings from the questionnaire.

Category 1: the design process is not similar to problem solving.

Category 3: the design process is more than problem solving.

Category 2 then fell off in this discussion.

It emerged that category two was no longer part of this discussion showing the change of understanding that the participants had as they were reflecting. This alludes to the fact that understanding does indeed change upon reflection.

<u>Category 1: the design process is not similar to problem solving</u>

Through reflection, an opportunity for dialogue was created, whereas, previously, teachers did not take note of their own and others' thoughts (Bentham, 2010). Schön (1983) states that as practitioners reflect in and on their practice, a form of development is noticed. The initial reflection phase prompts change of action which further compels another cycle of reflection. This is illustrated in the following excerpts:

> ***P2:*** *…in your analysis on the comment I made about design process being used interchangeably with problem solving you reduced your analysis to very useful ideas. I think the equation that is: DS is not equal to PS. Design process is not the same as problem solving and I think that is a correct analysis however in saying that it would be a mistake to understand that in a way which suggested that they were not similarities between the two.* (Appendix D1, Line 23-27)
>
> ***P6:*** *(interjects) I had the same thing here.* (Appendix D1, Line 28)
>
> ***P2:*** *So I am saying yes I agree they are not the same, and I think your analysis is correct but one must not understand that to mean that there is no similarity.* (Appendix D1, Line 30)

P6: *So, it means they are not …they are not synonymous but there are Common.* (Appendix D1, Line 31)

P2: *They are not the same.* (Appendix D1, Line 32)

P6: *You can't just swap the words but some aspects of problem solving do occur in technological design.* (Appendix D1, Line 33)

P4: *My thinking is that there are similarities and there are common areas that need to be linked for PS and DS to be effective for thought processes.* (Appendix D1, Line 145)

P1: *Design Process is not equal to problem solving. Problems are solved through the design process. PS is the force that drives D.P.* (Appendix C8, Line 5 &34)

From this dialogue of reflection it emerged that the participants view DS and PS as having commonalities though they are not the same. The participants' understanding showed certainty that DP is not similar to DS however they were uncertain about the commonalities between DS and PS. Only one participant was able to articulate that PS drives the design process. According to Education (2011, p. 9) problem solving, through using the design process, is identified as one of the key aspects in teaching Technology Education. It is the design process which guides the problem solving. Therefore, in Technology Education the term 'design process' is used interchangeably with 'problem solving'. Mawson (2003) argues that these concepts are similar, since they both have the same sequence of activities, which includes the inception of an idea, the reflection stage and evaluation of the success of the outcome. According to McCormick (2004) problem solving and the design process are forms of knowledge about how to proceed when engaging in a technological process.

Category 2: The design process is equated to problem solving

It is significant to note that this category didn't feature in the first group interview.

Category 3: The design process is more than problem solving

Four out of the seven participants still foregrounded the idea that the design process is more than problem solving. The notion of the design process being more than problem solving seems to signify the point that there is more to the design process than providing a solution to a problem or a need. Aspects, such as costs, aesthetics, emotions, skills, creativity etc. are seen as key in qualifying this category. From the excerpts below it is clear that the design process is a non-routine process. Different scholars argue that design problems are characterized by being dynamic, genuine, ill-defined, and complex and require integration of knowledge across a sphere of knowledge (Cross, 2004; Davids, 2007; Hennessy & Murphy, 1999).

> ***P1:*** *DP is a process which takes place within the process of problem solving. DP draws on the creativity, skills and craftsmanship, and emotions of the maker/designer. PS on the other hand is merely providing a solution. PS deals with the question "WHAT", DP deals with "HOW".* (Appendix C8, Line 18)
>
> ***P4:*** *DP can be applicable to another situation after evaluation while PS doesn't extend to evaluation may not be adapted to another situation.* (Appendix C8, Line 58)
>
> ***P6:*** *DP is more than problem solving however it does incorporate problem solving in the sense that… throughout, specific challenges will emerge and have to be dealt with. Design suggests the solution will have to be tailor-made, aesthetically pleasing, take ethics and cost etc. into consideration PS is rigid whilst DS is creative, uplifting.* (Appendix C8, Line 73)
>
> ***P7:*** *DP includes research, experiments looking at existing product designing trial and error and prototyping, sketches, evaluate.* (Appendix C8, Line 101)

The views above indicate that the design process is not just about solving a problem, but it is more than that as there are different activities that must be carried out in order to satisfy a need or want.

4.1.2.2 Graphic representation

As mentioned earlier in the introduction of this chapter data was collected from different sources. The reflecting 'in action' in the first focus group also required participants to provide a model which depicts their understanding of the relationship between the design process and problem solving.

It is significant to note that the two categories of description established through the narrative analysis were carried through into the graphic representation (modelling) of the participants' understanding of the relationship between the design process and problem solving. Interestingly, the participants' understanding shifted in two ways. First, variations within the first category were observed. Second, a new category was established, namely, problem solving is bigger than the design process. This new category forms the fourth category established in the analysis. The shift of understanding that took place confirms Schön's (1987) description of reflection in action which is that thinking about your action whilst in action is typically stimulated by surprise, which puzzles the practitioner concerned. According to Schön, the practitioner tries to make sense of the situation confronting them. Furthermore they reflect on the understanding which has been implicit in their action, feelings which led to the adoption of a particular course of action and the way they structured their problem initially (Schön, 1987). The analysis of the categories established through the analysis of the graphic representation is presented below.

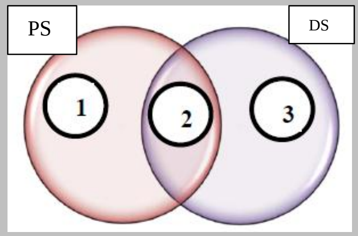
Category 1: the design process is not similar to problem solving

Two variations of this category were established, and were thus named category 1(a) and 1(b) respectively:

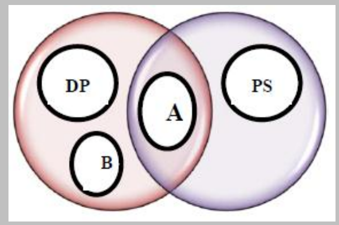
- Category 1(a): the design process is not similar to problem solving, however there is convergence; and
- Category 1(b): the design process is not similar to problem solving and there is no convergence.

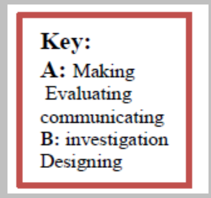
A summary of the analysis is provided in Figures 4.1 and 4.2.

Category 1(a): the design process is not similar to problem solving, however there is convergence

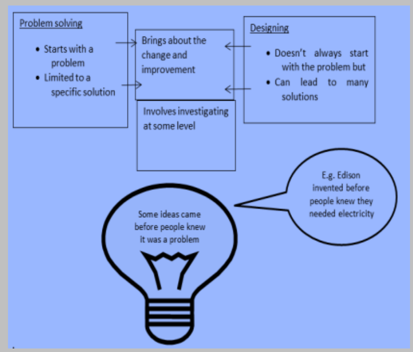


Participant 2





Participant 3



Participant 7

DP occurs in a specific context	PS occurs in an abstract and temporal context	DP involves all 5 stages	PS is solution based	DP leads to multi-solutions	PB leads to specific solutions
Convergence: Part 3		Convergence: Making, evaluating and Communicating		Convergence: investigation that leads to transformation	

Category 1(b):): the design process is not similar to problem solving and there is no convergence

Design Process	**Problem solving**
• **Evaluate solutions**	• Provide solution
• **Invites alternatives through collaboration**	• Provides **systematic** ways
• **Adaptive**	• Precise
• **Teamwork**	• Individual effort
	Participant 4

Figure 4.1: **Analysis of the graphic representation of Categories 1(a) and 1(b) on the relationship between the design process and problem solving**

As can be seen from Figure 4.1, four participants fell into the first category. The distinctive character of the design process was qualified with the following two features: with convergence and without convergence. With respect to the former, the participants not only focussed on the design process as skills, but saw it as a resource that has the power to transform the context within which it occurs.

Category 2: the design process is equated to problem solving

As mentioned earlier on this category did not feature.

Category 3: the design process is more than problem solving

Figure 4.2 illustrates Category 3.

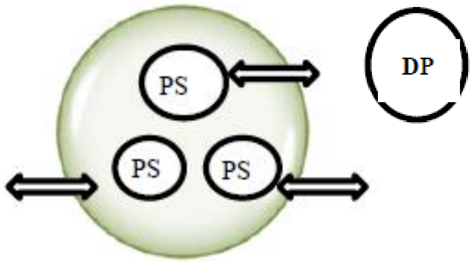
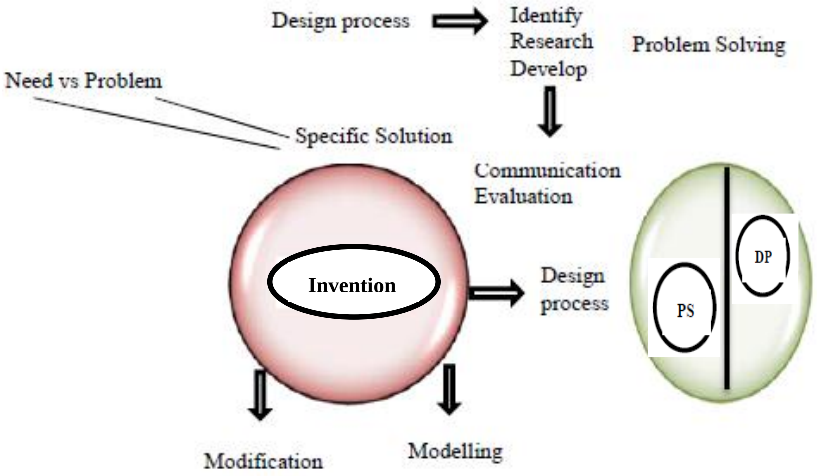
<table>
<tr><td colspan="3"><u>Category 3: The design process is more than problem solving</u></td></tr>
<tr><td>Relationship between the DP and PS

Work in progress
Participant 6</td><td colspan="2">
Participant 5</td></tr>
<tr><td>Problem solving embedded in the design process</td><td>DP is driven by a need</td><td>PS is driven by a problem</td></tr>
</table>

Figure 4.2: Analysis of the graphic representation of categories 3 – on the relationship between the design process and problem solving

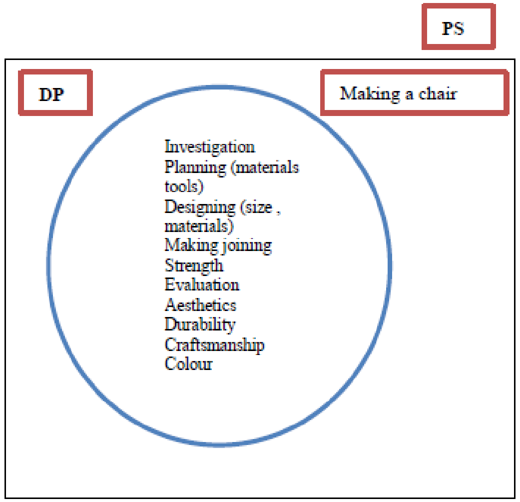
As can be seen from Figure 4.2, only two participants held this view. What is significant to note is the distinction that is made about what each process serves. The design process is seen to address a need whilst problem solving is seen to address a problem. In this regard, a sharp distinction is drawn between "need" and "problem".

Category 4: Problem solving is more than the design process

Figure 4.3 illustrates the results of Category 4.

<table>
<tr><td colspan="2">Category 4: Problem solving is bigger than the design process</td></tr>
<tr><td>

Participant 1



</td><td>DP is a tool to solve problems</td></tr>
</table>

Figure 4.3: Analysis of the graphic representation of categories 4 – on the relationship between the design process and problem solving

In contrast to the previous category which saw the design process being elevated to the status of being greater than problem solving, in this category, the design process is reduced to being a tool through which problems are solved.

4.1.2.3 Summary of the overall analysis of the findings on the relationship between the design process and problem solving as drawn from the questionnaire, the first group interview and the graphical representations

In the following section I provide a summary of the overall analysis of the findings as derived from the questionnaire, first focus group interview – the narrative and graphic representations.

Table 4.1: Summary of categories of findings from the 3 instruments at supra-individual level

Category	Questionnaire	Focus Group 1 (narrative representation)	Focus Group 1 (Graphic Representation)	
1	DP is not the same as PS	DP is not the same as PS	DP is not the same as PS	
			With convergence	Without convergence
2	DP is equated to PS	N/A	N/A	
3	DP is more than PS	DP is more than PS	DP is more than PS	
4			PS is more than DP	

In the summary above it is clear that when participants reflect in and on action their understanding changes. The three data sources indicate the variation of understanding.

4.2 ANALYSIS OF THE FINDINGS ON THE CONCEPTIONS OF THE DESIGN PROCESS

4.2.1 Exploration of ACE Technology lecturers' and teachers' understanding of the design process as drawn from the questionnaire

In distinguishing between the DP and PS, analysis reveals that the participants viewed problem solving as a ***general process*** whilst the design process was seen as a ***specific process***. This view of problem solving being a general process means that it can be applied in any discipline and in daily contexts. On the other hand DP as a specific process means that the made environment (material culture) is formed and continually modified. In terms of its specificity, the following five conceptions of design were elicited, as shown in Table 4.2 below.

Table 4.2: **Conceptions of the design process as drawn from the questionnaire**

Conceptions	Questionnaire
1	Design process is action orientated
2	Design process is not linear therefore it is iterative
3	Design process is solution based
4	Design process is appraisal and evaluation
5	Design process is systematic

These five conceptions that emerged clearly indicate that design is a complex dynamic process. Each conception is elaborated upon in the sub-sections below.

Conception 1: Design process is action orientated

This understanding was held by four of the seven participants, as presented in the following excerpts:

P1: *Design process involves team spirit where learners brainstorm ideas, drawing annotations, weighing up options, taking into consideration constrains, investing existing products so as to devise a way to adapt them to suit a need.* (Appendix C1, R2)

P1: *Design process is a long process involving, head, hands and emotions .Not just head.* (Appendix C8, Line 15)

P6: *The design process is used to encapsulate the actions taken by the technologist/learner to design and make an object to meet a need or a want. As such it incorporates many diverse actions both physical and mental. Physical action such as investigating, trying out experimenting, making constantly communicating, coming up with new ideas, always designing and adapting. Mental is cognitive which involves designing and adapting.* (Appendix C6, R2 & 3)

P5: *DP is an activity of determining the workflow, equipment needs and implementation requirements for a particular process.* (Appendix C5, R1)

P5: *DP as an activity that entails using a variety of tools i.e. research simulation / modelling, drawing, scale drawing and models.* (Appendix C5, R3)

P7: *Activities involved in DP are research, experiments, observations, interviews, surveys, designing looking at existing products.* (Appendix C7, R3)

As seen from the above excerpts the participants view the design process as an activity which involves the interaction of the head and hands and heart. This simply means that there is a lot of thinking that is transformed into action. The participants allude to the following actions: coming up with ideas, drawing, team spirit, communication, research etc.

Conception 2: Design process is not linear therefore it is iterative

Only three participants out of seven held the idea of the design process being iterative.

P5: *DP is not linear but usually cyclical in finding a solution whereby evaluation takes place throughout the process. A solution has room for improvement as Technology is ever-changing.* (Appendix C5, R4 & 5)

P6: *It is not linear but iterative process.* (Appendix C6, R5)

P7: *DP is not linear and it should not be prescribed for learners.* (Appendix C7, R7)

The views of the participants indicate that actions taken during the design process are not systematic and structured. The complexity of the design process is further emphasized by P7 foregrounding the idea that the design process should not be prescribed for learners. This sentiment is echoed in Kimbel's argument (as cited in Mawson, 2003) where he cautions against the presentation of the design process as a simple, linear, systematic process.

Conception 3: Design process is solution based

Design is seen as being solution driven, the participants qualify the notion of design being an activity. As can be seen from the excerpts below, four participants (three of whom fell under the first category) identified design as **solution** driven.

P4: *Result of intervention in finding a solution to a problem.* (Appendix C4, R2)

P1: *Design process is a process of finding a solution to a need.* (Appendix C1, R1)

P5: *Design process is a formation of a plan to devise a solution*. (Appendix C5, R1)

P7: *It is a way used by technologist to tackle a problem and look for solutions*. (Appendix C7, R2)

The design process is seen as a form of a plan or an intervention in finding a solution. It is interesting to note that although all four participants highlight the notion of design being solution driven, two draw the distinction between finding a solution to a need and a problem. In this regard, a distinction is drawn between "need and "problem".

Conception 4: Design process is appraisal and evaluation

Three of the seven participants attest to the idea of design being equated to evaluation and appraisal.

P1: *Design process is equated to appraisal and evaluation.* (Appendix C1, R2)

P3: *After making, solutions are evaluated then communicated to the public. If the solution failed during evaluation redesigning and making occur.* (Appendix C3, R4)

P6: *It incorporates diverse actions such as constantly communicating, coming up with new ideas and always designing and adapting.* (Appendix C6, R3)

From the above excerpts it is obvious that the design process is not rigid as the action or process of evaluation is continuous throughout, resulting in the generation of new ideas.

Conception 5: Design process is systematic

Only two of the seven participants held this view.

P1: *Design process is systematic because there are specific steps that must be followed. I say systematic because one can assume what the designer will do next*. (Appendix C8, Line & 13)

P3: *Design processes are stages followed through problem solving. After/during investigation designs for solutions are made followed by making, evaluation and communication.* (Appendix C3, R5)

The participants understanding of the design process indicate that the actions involved in the process are predictable as opposed to iterative. This contradicts Kimbel's argument (as cited in Mawson, 2003) where he cautions against the presentation of the design process as a simple, linear, systematic process.

4.2.2 Exploration of the conception of the design process through the second focus group interview

For the second group interview, only four out of the seven participants took part, namely, P1, P2, P6 and P7 as mentioned before. It was through the second focus group interview that the research aimed at arriving at a shared understanding of the design process. Through participative engagement using scholars who have conducted research and have written on the design process, participants had to reflect on action and it emerged that participants understanding increased. It is in this regard that Bruner (1990) states that reflecting as individuals should not be seen as an end to professional growth. He further states that when people talk with each other they learn. Reflecting with others shapes one's own philosophies, instruction etc. Solomon (as cited in Woodcock, Lassonde, & Rutten, 2004) concurs with Bruner that when reflection is framed as a social practice teachers' understandings become more clear and real as they speak about them to each other. In addition, the process encapsulates a close examination of personal belief. Hence, an atmosphere of trust is vital for meaningful, collaborative reflection to proceed. Table 4.3 overleaf summarizes the analysis. (Appendix D2, P1-4 Part 2)

Table 4.3: A summary of the analysis of conception of the design process at an individual level

Second Focus Interview	P1	P2	P6	P7
Has your idea changed?	Yes	Yes	No	Yes and No
What is your understanding now	the design process is problem driven.	I would say that my earlier diagrammatic representation of this relationship has changed and would now look more like the following- the design process is embedded in problem solving	My understanding of the DP incorporates a context that is relevant to the learner – and that the process involves action and cognition whilst the learner's capabilities are stretched to develop and make innovative products to meet relevant needs"	the design process is so much more than just working through specific "steps" or "responsibilities".
Elaborate	design has iterative patterns involving processes of conscious reflection and thought about the problem that needs to be solved in the made-world	designing is not an easy thing to describe and one's understanding of it grows.	Previously from reading, study and practice I had learned that the design process is a complex process that basically cannot be reduced to a simple formula.	I feel my understanding of the design process has broadened. I have also realized how very difficult it is to define or model and for many the models are quite varied.

As can be seen from the Table 4.3 above, three out of the four participants confirmed that their understanding did indeed change through the process of group reflection and literature reading intervention. In this regard, four conceptions of the design process were identified, as illustrated in Table 4.4 below.

Table 4.4: Conceptions of the design process as derived from the second group interview

Conceptions	Second Group Interview
1	Design process is a complex process
2	Design process is iterative
3	Design process is problem based
4	Design process is context-based

The above four conceptions as derived from the reflection in the second focus group interview are individually unpacked in the section below.

Conception 1: Design process is problem driven

There seems to be a relationship between design and problem solving. It emerged that the two concepts work hand in hand.

> ***P1:*** *the design process is problem driven.* (Appendix D2 part 2, P1)
>
> ***P2:*** *the design process is embedded in problem solving.* (Appendix D2 part 2, P2)

The views of the participants' indicate that in order to solve a problem the design process is used. It shows that the design process cannot be used in isolation as it has to be applied when there is a problem to solve. This statement accords with Hill (1998) stating that design processes guide problem solving in Technology education.

Conception 2: Design is context based

The participants foreground the idea of design being context based. They argue that the design process should be used in order to solve real life issues.

> ***P6:*** *My understanding of the DP incorporates a context that is relevant to the learner*. (Appendix D2, part 2, P6)
>
> ***P7:*** *I would choose Hill's model of design that foregrounds the relevance that comes with Technology tasks that set in real life contexts.* (Appendix D, Part 2, P7)

It is evident from the excerpts that the design process taught in schools should be transferrable and enables learners to solve real life problems. The excerpts indicate that technological problem solving using the design process should incorporate tasks which are situated in the real life context. Herrington, (2004) supports this idea as he states that learning within a realistic classroom situation provides useful real-life context for learners.

Conception 3: Design process is complex

Three out of four participants viewed the design process as being complex. It was evident that the participants found it difficult to describe the design process as it includes a variety of activities.

> ***P2:*** *Designing is not an easy thing to describe and one's understanding of it grows.* (Appendix D2 part 2, P2)
>
> ***P6:*** *I had learned that the design process is a complex process that basically cannot be reduced to a simple formula.* (Appendix D2, part 2, P6)
>
> ***P7:*** *The design process is so much more than just working through specific "steps "or "responsibilities". I have also realized how very difficult it is to define or model.* (Appendix D2, part 2, P7)

From the excerpts it is evident that the design process is indescribable as one cannot put it in simple terms. Because of its nature of being dynamic, context based and incorporating different forms of knowledge it cannot simplified. This accords with Lawson (2006) who notes that the design process is complex because of its iterative nature. Further to that, (Kangas, 2011) describe design problems as "wicked problems" because they are difficult and puzzling.

Conception 4: Design process is an iterative process

Two out of four participants held the idea that the design process is not a neat process as it incorporates diverse actions and is context based.

> ***P1:*** *design has iterative patterns involving processes of conscious reflection and thought about the problem that needs to be solved in the made-world* (Appendix D2 ,Part 2, P1)
>
> ***P6:*** *DP incorporates a context that is relevant to the learner –and that the process involves action and cognition.* (Appendix D2, Part 2, P6)

These views indicate that the design process is not structured. The aspects of the design process are not linear, they do not proceed in an orderly way because they involve the interaction of the head, heart and the hand.

4.2.3 Summary of the overall analysis of the findings on the conceptions of the design process as drawn from the questionnaire and the second group interview

In the following section I provide a summary of the overall analysis of the findings of Technology teachers' conceptions of the design process as derived from the questionnaire and the second group focus interview, at a supra-individual level, as illustrated in Tables 4.5 below.

Table 4.5: Summary of the overall analysis of the findings on the conceptions of the design process as drawn from the questionnaire and the second group interview at a supra-individual level

Conceptions	Questionnaire	Focus Group 2
1	Design process is action orientated	
2	Design process is not linear therefore it is iterative	Design process is iterative
3	Design process is solution based	Design process is problem driven
4	Design process is appraisal and evaluation	
5	Design process is systematic	
6		Design process incorporates a context
7		Design process is a complex process that basically cannot be reduced to a simple formula.

When comparing the findings from the two data sources, one can see that conceptions 2 and 3 were common to both. In this regard, only two new conceptions were identified in the second focus group interview, making the total number of conceptions identified throughout the two phases of the study, seven.

4.3 OVERALL ANALYSIS OF FINDINGS OF THE CONCEPTIONS OF THE DESIGN PROCESS – META-ANALYSIS

Table 4.6: Meta-analysis of the analyses of the relationship between the design process and problem solving as well as Technology Teachers' conceptions of the design process

Category	Questionnaire	Focus Group 1	Graphic Representation	
1	DP is not the same as PS	DP is not the same as PS	DP is not the same as PS	
			There is convergence	No convergence
2	DP is equated to PS	N/A	N/A	
3	DP is more than PS	DP is more than PS	DP is more than PS	
4			PS is more than DP	

Conceptions	Questionnaire	Focus Group 2
1	Design process is action orientated	
2	Design process is not linear therefore it is iterative	Design is iterative
3	Design process is solution based	DP is problem driven
4	Design process is appraisal and evaluation	
5	Design process is systematic	
6		DP incorporates a context
7		DP is a complex process that basically cannot be reduced to a simple formula.

The meta-analysis of the analyses of findings on the categories of description that emerged on the relationship between the design process and problem solving and the conceptions of the design process is conducted in order to arrive at a global picture of the Technology Teachers' understanding of the design process. From Table 4.6 above, it is evident from both analyses that participants had a variation of conception of understanding which was brought about by the particular methodology employed in the study: reflecting in action and on action. These understandings were derived from the analysis of the three data sources used in the study. The initial analysis as drawn from the questionnaire revealed two foci with regard to participants understanding of the design process. The first focus is the relationship between the design process and problem solving. Within this focus, three categories came to the fore when describing this relationship. Participants clearly articulated each of the categories. The second focus is the definition of the design process. Within the second focus, five conceptions of understanding the design process emerged. Participants were able to describe the distinct characteristics of the design process.

In the analysis of the narrative representation within the first focus group it is of note that a shift of understanding took place, and the second category that emerged from the questionnaire did not form part of the understanding in this source of data collection.

The analysis of the graphic presentation within the first focus group interview revealed another shift in understanding where problem solving was viewed as bigger than the design process forming the fourth category. However the two categories, categories 1 and 3, which emerged in the first focus group were still foregrounded. It is interesting to note that, with reference to category 1, points of convergence and divergence qualified the category.

When it comes to the elicitation of a shared understanding of the design process within the second focus group interview whereby the participants reviewed literature, their understanding emerged richer. It is worth noting though that participants found it difficult to define the design process because of its complexity and its contextual nature. The complexity of the design process is borne out of the fact that it is a multi-method process. This complexity of design is also qualified by the systematic actions involved. It emerged that participants found that the design process cannot be simplified into a series of steps because of the iterative requirement to refine ideas. This outcome is supported by Lawson (2006) who describes the design process as a complex process due to its cyclical and iterative nature.

Lastly in all the variations of understanding from the different instruments employed to constitute the data, it can be observed that the focus was on the distinct characteristic of the design. A global understanding of the design process emerged when looking at a cross analysis of instruments. As indicated in the table above, the meta-analysis shows that the participants in this study agree, to an extent, that the design process can’t be equated to problem solving. This understanding leads to a divergence in conceptualising the relationship between the two processes – the design process ends up being viewed as either being “bigger” or “smaller” than problem solving. In other words, it is either an overarching process or one that gets subsumed into problem solving. It is therefore this divergence that leads to the change and hence the variation in the conceptions of the design process and, ultimately, the seven conceptions of the design process generated in the study.

4.4 CONCLUSION

This chapter addressed the first research question which sought to explore Technology Teachers' understanding of the design process. This exploration was accomplished in three steps. First, I presented the analysis of the findings on the categories of description that emerged on the relationship between the design process and problem solving as drawn from the questionnaire and the two focus group interviews. Second, I presented the analysis on the findings on the conceptions of the design process as drawn from the questionnaire as well as the second focus group interview. Lastly, I presented a meta-analysis of the above two analyses in order to arrive at a global picture of the Technology Teachers' understanding of the design process. Seven conceptions of the Technology Teachers' understanding of the design process were derived. In the next chapter, I explore what influences and hence informs these teachers' understanding of the design process.

CHAPTER 5: PRESENTATION AND ANALYSIS OF THE SECOND RESEARCH QUESTION

The main objective of this chapter is to address the second research question:

What informs and influences ACE Technology Education lecturers' and in-service teachers' understanding of the design process?

To answer this question data was drawn from two focus group interviews. In this chapter data presentation will be according to the two factors that emerged through reflecting on action, on what influences and informs the participants understanding of the design process. The categories that emerged under this theme will then be discussed.

5.1 ANALYSIS OF WHAT INFORMS AND INFLUENCES ACE TECHNOLOGY LECTURERS' AND IN-TEACHERS'UNDERSTANDING OF THE DESIGN PROCESS

The analysis points to two major influences. The first influence seems to be brought about by the framework employed in the study: reflection in action. The overall analysis of the three data sources shows clear evidence that the participants' understanding is influenced by reflecting and interacting within a community of practice, which can be viewed as part of learning. The second influence appeared to be brought about by the interface between understanding and practice. The interface points to both divergences and convergences in this relation between understanding and practice. Understanding appears to get transformed as well as confirmed during practice.

In the following section, I elaborate further on the nature of each influence.

5.1.1 Analysis of how understanding is influenced by reflecting and interacting within a community of practice

The evidence that participants' understanding is influenced by reflecting and interacting within a community of practice is provided through the conceptual changes observed as derived from the participants' understanding of the relationship between the design process and problem solving as well as the concept of the design process. I discuss these changes by providing first a summary of the findings, as illustrated in Tables 5.1 and 5.2, followed by a brief analysis of the summary.

5.1.1.1 Conceptual changes observed as derived from the participants' understanding of the relationship between the design process and problem solving

Table 5.1: Summary of categories of findings from the 3 instruments at an individual level

Category of description	Questionnaire	First focus group	Graphic representation
DP is not the same as PS	P2, P6	P1, P2, P4, P6	P2, P3, P4, P7
DP is equated to PS	P1, P3, P4, P5, P7		
DP is more than PS	P1, P3, P4. P6	P1, P4, P6, P7	P5, P6
PS is bigger than DP			P1

When we started five participants had the same understanding that design is similar to problem solving. However, it is interesting to note that upon reflecting all five respondents changed their understanding and none had identified with the idea of design being equated to problem solving. Furthermore a new category which formed a fourth category came to the fore in the graphic representation.

<u>Participant 1</u>

This participant at first held two ideas of understanding which were contradictory in the first data collection. The participant understanding then shifted in the focus group where the design was conceived as not the same as PS. However this new conception was then qualified by DS, the statement of being more than PS. It is also interesting to note that she had a completely different idea in the third data source where DS was conceived as bigger than DS.

> ***P1:*** *In the essence, design process is a process of finding a solution to a need. Therefore it is in a way problem solving.* (Appendix C1, R1)

> ***P1:*** *Design Process is not equal to problem solving. Problems are solved through the design process … PS is the force that drives D.P.* (Appendix C8, Line 5 & 35)

> ***P1:*** *DP is a process which takes place within the process of problem solving. DP draws on the creativity, skills and craftsmanship, and emotions of the maker/designer. PS on the other hand is merely providing a solution. PS deals with the question" WHAT" DP deals with "HOW".* (Appendix C8, Line 18)

Participant 2

This participant's understanding was consistent throughout the three data sources. Although the participant foregrounded that DP and PS are not the same there is a relationship between the two.

> ***P2:*** *Problem solving and design process should not be used interchangeably.* (Appendix C2, R1)

> ***P2:*** *I think the equation that is: DS is not equal to PS. Design process is not the same as problem solving and I think that is a correct analysis however in saying that it would be a mistake to understand that in a way which suggested that they were not similarities between the two…. So I am saying yes I agree they are not the same, and I think your analysis is correct but one must not understand that to mean that there is no similarity.*
>
> **(**Appendix D1, Line 24)

Participant 3

The third participant held a view of understanding with a contradictory qualifier in the first data source. In the focus group the participant decided to listen to other participants without engaging in the discussion. In the third data source a completely different view of understanding came to the fore.

> ***P3:*** *Design processes are stages followed through problem solving. Design process involves the five stages that is investigation, design, make evaluate communicate.* (Appendix C3, R2)

Participant 4

At first the participant had contradictory ideas of understanding. Interestingly the second data source shows a shift of understanding with a qualifier which substantiates the understanding. Furthermore the participant maintained the same understanding in the third source of data.

> ***P4:*** *There is a thin line that separates the two but design process comes as a result of intervention in looking for a solution to a problem.* (Appendix C4, R1 & 2)
>
> ***P4:*** *My thinking is that there are similarities and there are common areas that need to be linked for PS and DS to be effective for thought processes.* (Appendix D1, Line 145)
>
> ***P4:*** *DP can be applicable to another situation after evaluation while PS doesn't extend to evaluation may not be adapted to another situation.* (Appendix C8, Line 58)

Participant 5

The participant held an idea in the first data source which shifted in the third data source. However these two ideas were contradictory. In addition it was noted that the participant decided to remain silent listening to others debating in the second source of data.

> ***P5:*** *Formation of a plan to help designer to devise a solution.* (Appendix C5, R1)

Participant 6

The participant starts off with two ideas which were articulated in response to the questionnaire. Furthermore the understanding was constant throughout the second and thirds data sources which had qualifiers substantiating the same idea.

> ***P6:*** *DP is more than problem solving however it does incorporate problem solving in the sense that… throughout, specific challenges will emerge and have to be dealt with. Design suggests the solution will have to be tailor-made, aesthetically pleasing, take ethics and cost etc. into consideration. PS is rigid whilst DS is creative, uplifting.* (Appendix C8, Line 73)

Participant 7

The participant had a different idea in the first source of data however it was interesting to note the change of understanding in the second and third source of data. Regarding the shift of understanding it can be concluded that the idea in graphic presentation is qualified by the idea in the first focus group.

> ***P7:*** *Design process is an approach to solve a problem. It is a way used by technologist/designers to tackle a problem and look for solutions.* (Appendix C7, R1 & 2)

> ***P7:*** *DP includes research, experiments looking at existing product designing trial and error and prototyping, sketches, evaluate.* (Appendix C7, R3)

5.1.1.2 Conceptual changes observed as derived from the participants' understanding of the concept of the design process

This section provides a summary of the conceptual changes observed in the ACE lecturers' and teachers' understanding of the design process as moved from the questionnaire to the second focus group interview. Table 5.2 below provides the illustration.

Table 5.2: Summary of findings on the conceptions of understanding as drawn from the questionnaire and the second group interview

Conceptions		Questionnaire	Focus Group 2
1	Design process is action orientated	**P1; P5; P6; P7**	
2	Design process is not linear therefore it is iterative	**P5; P6; P7**	**P6; P7**
3	Design process is solution based	**P1; P4; P5**	**P1; P2**
4	Design process is appraisal and evaluation	**P1; P3; P6**	
5	Design process is systematic	**P1; P3**	
6	DP incorporates a context		**P6; P7**
7	DP is a complex process that basically cannot be reduced to a simple formula.		**P2; P6; P7**

When comparing the findings from the two data sources, one can see that conceptions 2 and 3 were common to both. In this regard, only two new conceptions were identified in the second focus group interview, clearly indicating a richer level of understanding of the design process.

5.1.2 Analysis of how understanding is influenced by the interface between understanding and practice – how it gets transformed and confirmed in practice

In this section, I discuss the influence of practice on understanding under the following two categories:

- Understanding gets transformed during practice.
- Understanding gets confirmed during practice.

5.1.2.1 Understanding is transformed during practice

There seems to be a disjuncture between understanding and practice that causes understanding to be transformed. When understanding gets transformed that transformation talks to the following two issues:

- Contextual issues - curriculum, pedagogy and assessment
- Identity issues.
    - Personality
    - Teaching approach
    - Academic reading and qualification on the design process.

In the following section the above issues are discussed to show this disjuncture.

5.1.2.1.1 Contextual issues

Contextual issues in this chapter talk to pedagogical and curricular aspects. In the previous chapter context related to issues of relevance to learner. In this chapter these contextual issues impact on curriculum, pedagogy and assessment therefore they shape practice. It would seem that understanding is aligned to curricular demands. Curricular demands also include the achievement of outcomes through assessment. Assessment is an important element of educational policy. An assessment criterion is a measure used to test the students' knowledge and skills in achieving outcomes. In Technology Education the design process steps are used as assessment criteria to measure the knowledge, skills and understanding of the process of making products. These steps are clearly articulated by the teacher thus channelling the learner to use the design process in a linear way. Furthermore it is the assessment criterion that foregrounds the product instead of the process.

> ***P7:*** *Are we talking about classroom teaching here because that is a very real problem your understanding will be totally it's…. you have wonderful ideas how you would love to do it and but you are limited by curriculum and you are limited by assessment. You have to have something to mark at the end of the day so you kind of guide the way they going to work through the design process so you can at least have something that is sought of very clear what you are looking for there is this emphasis that the children have to know what are their assessment criteria what are they going to be marked on so you kind of say you are going to design but when you design you make sure you make an oblique drawing you are actually kind of spelling it out for them and so you are limiting them from this idea of sought freely working through design in their own way.* (Appendix D2, Line 201)

The excerpt above indicates that assessment criteria drives practice. As assessment criteria drives practice it causes understanding of design to be transformed from iterative process to linear process. An assessment criterion clearly outlines aspects that learners must meet during the process. From the above excerpts it is clear that a series of steps are outlined by the teachers, viz. identify-design-make-appraise, and students are expected to follow them diligently in their projects. The ideology behind this systematic process, Williams argues, is that it can be taught. Learners who learn it can then apply it in different problem-solving contexts (Williams, 2000). This rigid procedure is inviting to teachers, because it provides a structure for the teaching of Technology.

As mentioned earlier in this dissertation, context shapes practice. McCormick et al. (1994) attest that problem solving activity is shaped by available tools and resources and adapts to the specific, and changing, situation. Because of context, understanding appears to get transformed during practice. For example, P6 started with a particular understanding that the design process was seen as an action orientated process that includes physical and mental action. However in this session the participant seems to associate the design process with the linear process. This transformation of understanding in practice occurs mainly because of hybrid issues such as spaces and stakeholder demands.

> ***P6:*** *It does seem to suggest that you pass through these stages, just as you talk about final stage, when you come to practice you can hold fancy beliefs that it's like being iterative when you to practice but the constraints of your classroom can mean that you revert back to something more linear. I'm interested in how one could under the constraints of a large classroom and things like that, how you can actually do this iterative process in a true fashion how children go back and research for example Though we may hold this view we are constrained within our classroom so I would see class would be the actual context that teaching also affects your practice*. (Appendix D2, Line 190)

> ***P6:*** *it (practice) may not reflect your true view of design you will try to meet all the changes and make it as free and exciting as possible that there are constraints and therefore parents want to see a product but we also need to inform others that the process is important as the product that its actually coming out from the ideas and innovativeness that's important but practically the headmaster and everybody else wants to see a product and preferably not a scruffy one.* (Appendix D2, Line 221)

It is evident from this excerpt that context shapes practice. The participant highlighted the fact that even though one has a conception of the design process being iterative one is compelled to follow the linear process because of the nature of classes that exist in certain South African schools.

5.1.2.1.2 Identity

Teachers' professional identity is a multi-disciplinary concept and it is difficult to offer a clear cut definition. Complex as it is, many people hold a view that it is fixed whereas researchers reject this view by indicating that identity is fluid (McGregor, 2008; Olsen, 2008). Beijaard (1995) describes identity in general as 'who' or 'what' a person is, which includes various meanings that a person can attach to him/herself or the meaning attributed by others. In the teaching profession (Beijaard, 2004) define teachers' professional identity as a subject matter expert, pedagogical expert and didactical expert. In this study a number of issues are identified that qualifies one's identity. These issues are personality, teaching approach as well as academic reading and qualification. As teacher identity is fluid there are factors that interact with each other and these factors influence teachers' professional identity; these are teaching context, teaching experience and biography of the teacher (Beijaard, 2004)

5.1.2.1.2.1 Personality

It is it is interesting to note that one's identity as described by (Beijaard, 2004) is strongly interwoven with how one acts. Therefore it is improbable that the core of the personal will not impact on the core of the professional. It was noted that participants felt that one's personality will have an effect on how one views the design process and the way one teaches it.

> ***P6:*** *One could almost say one's personality ehmm it works both ways. Your personality almost has an effect on the way you view the DS and the way you teach. That's what I have been really starting to think about.* (Appendix D1, Line 64)

> ***P7:*** *Nash the SA designer he doesn't he didn't study formal design he just pick up bottles and looks at them and start cutting and snipping until he has made something so that would be like his personality and his approach if he had to go into the classroom and actually teach he would probably do the same with learners maybe tell them to just try this up pick this up see what you can do because that's what he himself does* (Appendix D1, Line 74)

Two things were emphasized by the participants, namely, personality and how personality affects teaching. From this view it is evident that people are unique and it is their uniqueness that will transpire in practice.

5.1.2.1.2.2 Teaching approach

Participants emphasized the point that one's approach to teaching will have an effect on how one views the design process.

P6: *One could almost say one's personality ehmm it works both ways .Your personality almost has an effect on the way you view the DS and the way you teach. That's what I have been really starting to think about.* (Appendix D1, Line 64)

P6: *I think the way you look at the design process is also affected by the way you look at teaching and learning. I think different people approach teaching in a different way some people like everything to be organised so that no surprises spring up another type of person has a much looser framework because that's the way they teach and it's not tightly planned beforehand.* (Appendix D1, Line 54)

P7: *And maybe the way you yourself design. Because we do approach things differently and if you state different designers they have different approaches so maybe when you teaching you do more [ ] or else if you have not really sat down and designed yourself maybe you are more bound by the curriculum that kind of then describe the DP that we do it this way so I think that also plays a role to the way you approach the DP.* (Appendix D1, Line 67)

In the aspect of teaching approach the view amongst the participants was that people have different approaches to teaching therefore the way they will structure their teaching depends upon their conception of teaching and learning. There are many factors which can influence teachers approach in teaching including teachers' ideas about pedagogy, contextual factors such as curriculum, school policy, learners etc. (Blignaut, 2008).

Technology teachers' understanding of the nature of the design process and learning will have an impact on their views about pedagogical approaches to teaching the design process. In addition knowledge of teaching strategies for how to equip learners with skills of solving problems (Jones, 2013) can be drawn upon. Past personal history also provides a knowledge base from which a teacher can draw. Studies on approaches to teaching reveal that certain approaches are effective for example the findings from McGregor's (2008) case study indicate that task structure can have an effect on the naturalness and level of social interaction when students work collaboratively. This shows that in order to develop creativity and critical thinking among students, teachers should be conscious of how they structure problem-solving tasks.

5.1.2.1.2.3 Academic reading and qualification on design

Curriculum development of Technology has been taking place in many countries. Different models already exist. A model that was influential is Design and Technology of England which was the first in the world to be introduced responding to the British economy. Later revisions were made focusing on designing and making and developing technological capability for all pupils (Mawson, 2003). Given the background on the development of Technology there seems to be an interconnection of what informs ones' understanding which is based on which origins of a particular model one has read.

In this study it was evident that there is a link between one's view and one's academic reading on Design and Qualification. The more reading one does the more one's understanding is influenced and broadened.

> ***P7*****:** *l think the difference between DS and PS and I was also kind of thinking that when we were discussing that it also depends on your reading and your qualification in a way and how much academic experience you might have because the word PS is very different depending on what you reading so if you just hear the word PS and you haven't done any kind of academic reading on it then in a way it is DS because you are trying to solve a problem but if kind of look at ok let's go back to the original founders of PS method and methodology then it also going to change your picture of what DS is and what PS is.* (Appendix D1, Line 90)

Evident from the excerpt is that one's understanding of DS and DP relies on how much one has reviewed literature on these two concepts. The participant in this excerpt views qualification as playing an important role in broadening ones understanding.

5.1.2.2 Understanding is confirmed during practice

When understanding gets confirmed in practice it talks to issues of authenticity. In other words authenticity means genuine or real. Hill (1998) argues that aligning the design problems with real life contexts improves learning and develops children's thinking capabilities in terms of human and environmental results of their design. Hill argues that it is necessary to teach authentically. Authentic teaching and learning therefore takes into account the knowledge taught in schools to be used as a tool in solving real life problems. In addition learning and context are seen as inseparable (Herrington, 2004).

Through reflecting on action it emerged that there seems to be an alignment of the participant's understanding that existed before and how it will be enacted in classroom practice. Participant 2 described earlier in the questionnaire that DP is a specific process which entails a process whereby the made environment is formed and continually modified. He further expatiated that the 'made environment' or the 'material culture' is a manifestation of humans' historic and on-going attempt to shape the landscape (exploit the natural world) so that it serves their needs and interests. This process 'shapes' or 'modifies' the natural landscape. From the understanding that the participant has, there seems to be a need to teach authentically as it accords with Hill's argument. According to the participant authenticity would create a classroom environment that allows practice that replicates professional designers practice.

> ***P2:*** *But isn't this the real professional teachers that we need navigate….. because when we say practice she is talking educational practice rather than the real life practice the constrains and difficulties of educational may mean that design in classroom doesn't look exactly like what design looks in practice in professional studios but I would say for teachers if we are wanting to teach design surely the real challenge for us is how can we make our classroom and what happens in our classroom make it more authentic in terms of making it more like what a real design in the studios and that's where these constrains for me need to be circulated and debated because there will be difficulties in doing so but you see if we simply give in to the fact that there are problems in the classroom then what you will be teaching in the classroom is never going to be the same as what these people and these children's ultimate do in real life and here lies the problem.* (Appendix D2, Line 206)

From the excerpts it also emerged that there is a disjuncture between conception of understanding and practice regarding teachers constructing the design process based on challenges they face in the classroom.

Participant 2 foregrounds the fact that problem solving using the design process in the classroom must mimic what professional designers do when they solve real life problems in studios. If learners are provided with authentic design activities in the classroom they will be able to apply these skills to solve real life problems taking into consideration human and environmental issues in their designs. This means that learners should be taught in a way that will enable them to be functional in society. This is in accordance with Hill's (1998) argument that the design, make and appraise cycles in schools are not aligned to students' world as they are assigned on briefs given by teachers which then leads to design processes that are linear and systematic.

The teacher is then driven to teach design a particular way that has limitations as it does not allow learners to deal with reality. Dunn and Larson (as cited in Hill, 1998) concur that the most important point is when teachers move from theory into actual practice, and how a teacher moves through design processes is an exclusive and individual experience.

5.2 CONCLUSION

This chapter discussed the data from the focus group interviews. This data was used to answer the research question: "What informs and influences ACE Technology Education lecturers' and in service teachers' understanding of the design process". Two factors were observed to inform the participants understanding: a) reflection and interaction within a community of practice and, b) the interface between understanding and practice. The evidence that points to participants' understanding being influenced by reflecting and interacting within a community of practice was brought to the fore through the conceptual changes observed as derived from the participants' understanding of the relationship between the design process and problem solving as well as the concept of the design process. The evidence that points to participants' understanding being influenced by the interface between understanding and practice was provided by the points of divergence and convergence in talking about the relationship between understanding and practice. The findings revealed two things. First, that understanding is transformed during practice because of extenuating circumstances such as hybrid spaces and stakeholder demands since these factors change the iterative nature of the design process. In this regard, the participants feel compelled to align their uunderstandings to curricular demands – assessment criteria drives practice. Second, that understanding is confirmed during practice. Issues of relevance seem to shape practice. In other words, authenticity seems to drive practice. In the next chapter I discuss the findings guided by reflection in and on action.

CHAPTER 6: DISCUSSION OF FINDINGS

In the previous chapters I presented the analysis and findings to the two research questions that guided the study, namely:

- *What are ACE Technology Education lecturers' and in-service teachers' understanding of the design process?*
- *What informs ACE Technology Education lecturers' and in- service teachers' understanding of the design process?*

In this chapter I summarize the findings and discuss only salient points that came to the fore during the analysis of the above two research questions. In addition, I conclude the chapter by providing recommendations and suggestions for future research.

6.1 SUMMARY OF FINDINGS

When considering the understanding of ACE lecturers and in-service teachers of the design process the findings indicate a variation of understanding. The variation of understanding was brought about due to reflection in action and on action (see Table 4. 4) within a community of practice. Through reflection an opportunity of dialogue was created, whereas before "teachers did not take note of their and others thoughts" (Bentham, 2010). According to Schön (1983) when practitioners reflect in and on their practice a form of development is noticed. The initial reflection phase prompts a change of action which further compels another cycle of reflection. In this regard, a shift of understanding is noted. This was evident throughout the three data sources as represented in the meta-analysis of the first research question in Table 6.1 below. Note: This table was used in Chapter 4, for the sake of clarity and convenience, I show the table here again:

Table 6.1: Summary of findings from Research Question 1

<table>
<tr><th>Category</th><th>Questionnaire</th><th>Focus Group 1</th><th colspan="2">Graphic Representation</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">DP is not the same as PS</td><td rowspan="2">DP is not the same as PS</td><td colspan="2">DP is not the same as PS</td></tr>
<tr><td>There is convergence</td><td>No convergence</td></tr>
<tr><td>2</td><td>DP is equated to PS</td><td>N/A</td><td colspan="2">N/A</td></tr>
<tr><td>3</td><td>DP is more than PS</td><td>DP is more than PS</td><td colspan="2">DP is more than PS</td></tr>
<tr><td>4</td><td></td><td></td><td colspan="2">PS is more than DP</td></tr>
</table>

Conceptions	Questionnaire	Focus Group 2
1	Design process is action orientated	
2	Design process is not linear therefore it is iterative	Design is iterative
3	Design process is solution based	DP is problem driven
4	Design process is appraisal and evaluation	
5	Design process is systematic	
6		DP incorporates a context
7		DP is a complex process that basically cannot be reduced to a simple formula.

What is significant is that as we moved from the questionnaire to the first group interview, focusing on the graphic representation, a shift of understanding was noted and a new category emerged. Having analysed all the data sources it is evident that participants had a variation of conception of understanding. These changes in understandings, which are brought about by a conscious reflective process, are seen as part of what influences and informs the participants' understanding. In all the variations of understanding from the different data sources it can be observed that participants were compartmentalizing design in a way that it was possible to identify distinct characteristic of design.

However when it comes to the shared understanding where participants had reviewed literature a richer understanding was noted. Reflection is a cyclical process which increases knowledge and this is what develops one as a teacher (Schön, 1983). A common understanding of the design process emerged. When looking at across analysis of instruments (see Table 4.4) it is worth noting that although their understanding broadened, participants realised that the design process cannot be described in simple terms as it is complex because of its contextual nature which involves evaluation of the systematic actions.

Arguing along the same lines is Lawson (2006) who states that design processes are not linear; possible solutions come from a complex interaction between parallel refinements of the design problem and ever changing design ideas. Schön (1987) supports Lawson's idea that design process is a process of trying out meaning through practical moves. Furthermore, as stated in Chapter 2, Roden (1999) found that when children apply strategies in problem solving, a variation of strategies are used as children grow older. It is mentioned that children reflect on previous experiences and their knowledge is extended in terms of complexity of the process. It is evident that understanding broadens or develops as people reflect on their actions.

6.2 DISCUSSION OF FINDINGS

6.2.1 What are ACE Technology Education lecturers' and in-service teachers' understanding of the design process?

Out of the seven conceptions (see Table 6.1) that emerged from the analysis, in this section, I only discuss the following three conceptions:

- Design process is problem driven.
- Design process is complex.
- Design process is an iterative process.

The above three conceptions are foregrounded for discussion because they add an interesting nuance to the debates about how the design process should be conceptualised to allow for creativity and innovation in the teaching of Technology.

6.2.1.1 Design process is problem driven

It is evident from the data collected that the design process and problem solving are intertwined. It is through reflection-on-action that participants' came to an understanding that the design process is embedded in problem solving. As stated in earlier chapters, the Department of Basic Education (CAPS) (2011, p. 9) states that problem solving, through using the design process, is the key aspect to teaching Technology Education. It is the design process which guides problem solving. Mawson (2003, p. 118) argues that these concepts are similar, since they both have the same sequence of activities, which includes the inception of an idea, the reflection stage and evaluation of the success of the outcome. It is the reason why, in Technology Education the term ‘design process’ is used interchangeably with ‘problem solving’. According to McCormick (2004) problem solving and the design process are forms of knowledge about how to proceed when engaging in a technological process.

6.2.1.2 Design process is complex

The findings of the study upon reciprocal reflection-in-action and reflection-on-action indicate that ACE technology lectures’ and in-service teachers’ find it difficult to describe what the design process is as it is complex. Its complexity is based on its contextual nature as it involves evaluation of systematic actions. The complexity of the design process accords with Lawson’s (2006) view that design is a complex process which stems from its cyclical and iterative nature. Furthermore, Lawson states that the process is not linear; possible solutions come from a complex interaction between parallel refinements of the design problem and ever changing design ideas. The curriculum does not provide a suitable guideline depicting the complexity of the design process. It is for this reason that the participants realised after a series of reflective thinking exercises that complexity of the design process is their most important understanding. Initially participants’ understanding was focused on the “what” question of the design as is evident in Table 4.4 under conceptions of design. As mentioned in Chapter 2 different scholars argue that design problems are characterised by being dynamic, ill-defined and complex and require an integration of knowledge.

According to Hynes (2012) the step of redesign is very important for teachers to understand as students need to learn from trial and error. Schön (1987) describes design as reflection in action as he sees design as discovering a framework of meaning in an indeterminate situation through practical operations in the situations. Schön states that reframing the problem and having reflective conversation with the materials of the design situation is part of reflection in action. He further states that the master (teacher) should use demonstration, imitating, telling and listening which should form part of reciprocal reflection in action in order to develop students understanding. In return the student should perform his/her understanding of the master to show effectiveness of the intervention; thus, the student is reflecting in action.

In this study it became evident that the design process is context based meaning that it should be relevant to learners therefore technological problem solving should be situated in real life contexts. Design activities which are not relevant to the learner or are not context based hinder the development of creativity and critical thinking which learners need to solve real life problems. It is for this reason, as mentioned in Chapter 2, that learning through the design process is enhanced by the creation of authentic learning experiences which have some value and meaning to the learner (Lave and Wenger, 1991). This means extending the learning experience beyond the technology classroom setting into the wider community. This accord with Herrington and Oliver (1995) who proposed that a model of instruction based on situated learning be used in the design of learning environments. They stating that context should reflect the way knowledge will be used in real life including the complexity of the real world. Hill (1998) further argues that aligning the design problems with real life contexts improves learning and develops children's thinking capabilities in terms of human and environmental results of their design. Dagan and Mioduser (2007) attest to Hill's argument that students need to engage with the design process which should provide them with authentic real-life problem contexts in order to develop their capabilities.

The findings of this study indicate that the complexity of the design process also involves evaluation of systematic actions. The evaluation of the elements/actions in the design process increases reflection by developing understanding of the design problem and provide ample alternative pathways of arriving at an appropriate solution.

6.2.1.3 Design process is an iterative process

Upon reflection, the complexity of the design process was emphasized by participants thereby foregrounding the idea that the design process should not be prescribed for learners since it is open ended. It is also important for teachers to understand the nature of design so as to develop problem solving capabilities in learners. Kangas et al. (2011) state that designing is not just a practical activity simply putting conceptual ideas into practice. He further states that design is a process which involves designing and materially constructing embodied artefacts, which involves a multi method process. As mentioned in Chapter 2 when children are involved in their Technological practice they use a variety of strategies such as starting with materials, seeking guidance from outside etc. (Roden, 1999). This sentiment is echoed in Kimbel's argument (as cited in Mawson, 2003) where he cautions against the presentation of the design process as a simple, linear, systematic process.

6.2.2 What informs and influences ACE Technology Education lecturers' and in-service teachers' understanding of the design process?

With respect to the second research question, two factors were observed to inform and influence the participants' understanding:

- Reflection and interaction within a community of practice and,
- The interface between understanding and practice.

6.2.2.1 Reflection and interaction within a community of practice

Seeing that this section has already been touched upon in the introduction to this chapter. To avoid redundancy, I will point to challenge that this reflection in and on action brings about, a challenge that is revisited in section 6.2.2.2 overleaf.

We can unequivocally state that from this study it is evident that reflection and interacting within a community of practice broadens one's understanding. However, the findings also revealed that this reflection-in-action shows that teachers face challenges when understanding meets practice because this causes transformation and confirmation of understanding during practice. This is likely to limit the development of the creativity and critical thinking skills of learners which should be developed when learners are engaged in the design process (Dagan and Mioduser, 2007).

6.2.2.2 Interface between understanding and practice

Practitioners find it difficult to implement the design process as it is complex. Findings revealed that when practice interfaces with understanding then understanding gets transformed and is confirmed during practice. Participants understanding broadened through reflection-on-action in the earlier part of data collection. It is in this regard that Bruner (1990) states that reflecting as individuals should not be seen as an end to professional growth. He further states when people talk with each other they learn. In this reflection it was evident that people held the same understanding and there was growth in their understanding. However Dunn and Larson (as cited in Hill, 1998) state that the most important point is when teachers move from theory into actual practice, and how a teacher moves through design processes is an exclusive and individual experience. Although participants were aware of the creative, iterative nature of the design process, findings revealed that their understanding is bound by contextual and identity factors. It is for this reason that the data revealed transformation of understanding during practice is related to contextual issues and identity. Contextual issues include pedagogical and curricular issues. Identity refers to personality, teaching approach and academic reading and qualification. Contextual issues and identity compel teachers to change their understanding and follow a linear design process as they try to impose order on what is a confused interactive process. It is evident that understanding is aligned to curricular demands. Curricular demands emphasise the achievement of outcomes through assessment. Assessment is an important element of educational policy. An assessment criterion is a measure used to test students' knowledge and skills in achieving outcomes. In Technology Education the design process steps are used as assessment criteria to measure the knowledge, skills and understanding of the process of making products. The findings revealed that the elements of the design process are clearly articulated by the lecturers and teachers thus channelling the learner to use the design process in a linear way. Furthermore it is the assessment criterion that foregrounds the product instead of the process.

The aspects of the design process are not being applied effectively to develop learners into creative and critical problem solvers. Learners are following the design process in a linear way and are not engaging in developing their own ideas and design but those of their teachers. This contradicts with what Schön (1987) says which is that design is a creative process whereby a designers reflective conversation with the materials of a situation can result in new discoveries, meanings and inventions. In addition, as mentioned in Chapter 2, Milne (2013) states that teachers find it difficult to teach design process in a functional approach as teaching is guided by curriculum goals. Teachers tend to see the design process as a sequence of steps thus they teach and assess as such. This is because the curriculum underplays the complexities of the design process. Williams (2000) further argues this rigid procedure is inviting to teachers, because it provides a structure for the teaching of Technology. The ideology behind this systematic process is that it can be taught. Learners who learn it can then apply it in different problem-solving contexts (Williams, 2000).

With regard to pedagogical issues, the findings revealed that context shapes practices. The transformation of understanding occurs mainly because of hybrid issues such as stakeholder demands and classroom spaces. Principals and parents have a misconception that Technology is about making products. The demands made by principals and parents in wanting to see the finished product is compounded by class size which compels teachers to follow a linear process as the process of being creative requires a lot of time. Thus the linear process reduces the design process into a series of products. According to McCormick et al (1994) problem solving activities are shaped by tools, resources available and adapt to specific and changing situations.

In terms of identity, the findings revealed that personality, teaching approach and academic qualification drives one’s understanding of the design process. Identity not only directs pedagogical practice but it impacts learning with regard to critical thinking and creativity. It is important that practitioners have an in-depth understanding of the design process so as to be able to provide detailed explanations of the process to learners. Schön (1987) states that teachers play an important role as coaches to teach knowledge and reflection when dealing with design problems. As coaches their task is to move alongside the novice demonstrating and translating the languages of demonstrations and descriptions into the language of the novice learner. Lastly coaches should establish a good relationship with the learner.

In addition to the interface between understanding and practice the findings indicate that understanding is confirmed during practice. It emerged that problem solving using the design process in the classroom should mimic what professional designers do when they solve real life problems in studios. Authentic real life learning experiences should be provided as creativity, critical thinking and problem solving skills are important aspects of Technology Education. This accords with McCormick (2004) as he states that a feature of situated learning is that the activity should be authentic. He further states that problem solving activity should be something that has meaning for the learners as it should relate to the technology world outside the school. It was observed that some participants do not provide authentic learning experience for their learners as they are limited by contextual issues as mentioned previously. It was evident that participants seemed to be content with the contextual issues and were not thinking of alternatives approaches. This issue contradicts Kangas et al's (2011) study regarding the benefits of involving a professional design expert in a technology classroom. This action benefited students in imitating professional practices and constructing an in-depth understanding of the full holistic design process.

6.3 RECOMMENDATIONS

As the study focused on ACE lecturers' and teachers' understanding of the design process the finding reveals that practitioners are facing challenges in addressing the aims of curriculum and teaching the design process which is non-linear and complex. Having said that, a call for programmes of negotiated interventions is required. The interventions should be in the form of professional development. This calls for subject advisors to ensure that the facilitators are knowledgeable about the nature of design and approaches used to teach design taking into consideration South African contextual issues. It is of importance that the workshops run over a long period in different quarters in a year thus allowing teachers to develop their understanding, reflect on their understanding and enactment of the design. Such reflection will also develop practitioners' identity as Beijaard (2004) describes professional identity which includes subject matter expert, pedagogical expert and didactical expert. Enhancement of teaching practice will also take place.

6.4 FURTHER RESEARCH

Technology Education is still a new learning area in South Africa and not much research has been conducted here compared to other countries. A more in-depth study involving a larger sample of teachers' at the classroom level and tertiary level investigating how the design process is taught and learned is recommended.

Another study of a similar nature that explores subject specialists' understanding of the design process should be undertaken.

REFERENCES

Adams, R. S. (2001). *Cognitive processes in iterative design behavior.* University of Washington Seattle.

Adams, R. S., Turns, J., & Atman, C. J. (2003). Educating effective engineering designers: The role of reflective practice. *Design Studies, 24*(3), 275-294.

Anning, A. (1997). Teaching and learning how to design in schools. *Journal of Design & Technology Education, 2*(1).

Babbie, E. R., & Mouton, J. (2001). *The practice of social research*. Cape Town: Oxford University Press Southern Africa.

Bassey, M. (1999). *Case study research in educational settings*. Columbus, OH: McGraw-Hill International.

Beijaard, D. (1995). Teachers' prior experiences and actual perceptions of professional identity. *Teachers and teaching: Theory and Practice, 1*(2), 281-294.

Beijaard, D., Meijer, P. C., & Verloop, N. (2004). Reconsidering research on teachers' professional identity. *Teaching and teacher education, 20*(2), 107-128.

Bentham, H. (2010). *An action research study exploring how three grade 9 teachers develop their understanding and practice of "education for sustainable development".* M.Ed, University of KwaZulu-Natal. http://hdl.handle.net/10413/1162

Blignaut S 2008. Teachers' sense-making and enactment of curriculum policy. *Journal of Education,* 43:101-125.

Bruner, J. S. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Bungum, B. (2006). Transferring and transforming technology education: A study of Norwegian teachers' perceptions of ideas from design & technology. *International journal of technology and design education, 16*(1), 31-52.

Chapman, G. A. (2002). Design analysis of the Grade 9 technology curriculum in South Africa. M.Ed, University of KwaZulu-Natal. http://hdl.handle.net/10413/1782

Clark, V. L. P., Creswell, J. W., Green, D. O. N., & Shope, R. J. (2008). Mixing quantitative and qualitative approaches. *Handbook of emergent methods*, 363-387.

Coghill, V. (1989). Making and playing, the other basic skills: design education for the early years. *Looking, making and learning: Art and design in the primary school.* London, UK: Kogan Page.

Cohen L, Manion L & Morrison K 2007. *Research methods in education* (6th ed). London: Routledge.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education*. London; New York: Routledge.

Crilly, N., Blackwell, A. F., & Clarkson, P. J. (2006). Graphic elicitation: using research diagrams as interview stimuli. *Qualitative Research, 6*(3), 341-366.

Cross, N. (2004). Expertise in design: an overview. *Design Studies, 25*(5), 427-441. doi: http://dx.doi.org/10.1016/j.destud.2004.06.002

Darke, P., Shanks, G., & Broadbent, M. (1998). Successfully completing case study research: combining rigour, relevance and pragmatism. *Information systems journal*, *8*(4), 273-289.

Davids, J. C. (2007). Architecture and identity : the perception and reflection of identity through architectural expression : a South African case study. M.Arch, University of KwaZulu-Natal. http://hdl.handle.net/10413/2323

Department of Basic Education. (2011). Curriculum and Assessment Policy Statement (CAPS): Department of Basic Education Pretoria.

Eraut, M. (1994). *Developing professional knowledge and competence*. Hove, UK: Psychology Press.

Fleer, M. (2000). Working technologically: Investigations into how young children design and make during technology education. *International journal of technology and design education, 10*(1), 43-59.

Golomb, C. (2003). *The child's creation of a pictorial world*. Hove, UK: Psychology Press.

Gray, D. E. (2009). *Doing research in the real world*. Los Angeles: SAGE.

Gustafson, B. J., & Rowell, P. M. (1998). Elementary children's technological problem solving: selecting an initial course of action. *Research in science & technological education, 16*(2), 151-163.

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of research on technology in education*, *41*(4), 393-416.

Hennessy, S., & Murphy, P. (1999). The potential for collaborative problem solving in design and technology. *International journal of technology and design education, 9*(1), 1-36.

Herrington, J., & Oliver, R. (1995). Critical characteristics of situated learning: Implications for the instructional design of multimedia. Edith Cowan Unversity.

Herrington, J., Reeves, T. C., Oliver, R., & Woo, Y. (2004). Designing authentic activities in web-based courses. *Journal of Computing in Higher Education*, *16*(1), 3-29.

Hill, A. M. (1998). Problem solving in real-life contexts: An alternative for design in technology education. *International journal of technology and design education, 8*(3), 203-220.

Hong, Y.-C., & Choi, I. (2011). Three dimensions of reflective thinking in solving design problems: A conceptual model. *Educational technology research and development, 59*(5), 687-710.

Hope, G. (2009). Beyong knowing how to make it work: The conceptual foundations of designing. *Design and technology education: an international journal, 14*(1).

Hynes, M. (2012). Middle-school teachers' understanding and teaching of the engineering design process: a look at subject matter and pedagogical content knowledge. *International journal of technology & design education, 22*(3), 345-360. doi: 10.1007/s10798-010-9142-4

Johansson, R. (2003, September). Case study methodology. In *the International Conference on Methodologies in Housing Research, Stockholm*.

Jonassen, D. H. (2011). *Learning to solve problems: A handbook for designing problem-solving learning environments*. New York: Routledge.

Jones, A. (2013). Vanwyk Khobidi Mbubzi Chikasanda, Kathrin Otrel-Cass, John Williams &. *Int J Technol Des Educ, 23*, 597-622.

Kangas, K., Seitamaa-Hakkarainen, P., & Hakkarainen, K. (2011). Design expert's participation in elementary students' collaborative design process. *International journal of technology and design education*, 1-18. doi: 10.1007/s10798-011-9172-6

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*: Cambridge university press.

Lawson, B. (2006). *How designers think: the design process demystified*. New York: Routledge.

Lloyd, P., & Scott, P. (1994). Discovering the design problem. *Design Studies, 15*(2), 125-140.

Mawson, B. (2003). Beyond the design process: An alternative pedagogy for technology education. *International journal of technology and design education, 13*(2), 117-128.

Maxwell, J. A. (2005). *Qualitative research design : an interactive approach*. London: SAGE.

McCormick, R. (2004). Issues of learning and knowledge in technology education. *International journal of technology and design education, 14*(1), 21-44. doi: 10.1023/B:ITDE.0000007359.81781.7c

McCormick, R., Murphy, P., & Hennessy, S. (1994). Problem-solving processes in technology education: A pilot study. *International journal of technology and design education, 4*(1), 5-34.

McGregor, D. (2008). The influence of task structure on students' learning processes: observations from case studies in secondary school science. *Journal of curriculum studies, 40*(4), 509-540.

Middleton, H. (2005). Creative thinking, values and design and technology education. *International journal of technology and design education, 15*(1), 61-71.

Milne, L. (2013). Nurturing the designerly thinking and design capabilities of five-year-olds: technology in the new entrant classroom. *International journal of technology and design education, 23*(2), 349-360.

Milne, L., & Edwards, R. (2013). Young children's views of the technology process: an exploratory study. *International journal of technology and design education, 23*(1), 11-21.

Mioduser, D., & Dagan, O. (2007). The effect of alternative approaches to design instruction (structural or functional) on students' mental models of technological design processes. *International journal of technology and design education, 17*(2), 135-148.

Moreland, J., & Jones, A. (1999). *Research in Assessment of Primary Technology (RAPT) Project: Case studies of classroom practice in technology*: Centre for Science, Mathematics and Technology Education Research, University of Waikato.

O'Leary, Z. (2004). *The essential guide to doing research*. London: Sage.

Olsen, B. (2008). Introducing teacher identity and this volume. *Teacher Education Quarterly, 35*(3), 3-6.

Potgieter, C. (2013). Teaching practice trends regarding the teaching of the design process within a South African context: a situation analysis. *International journal of technology and design education, 23*(4), 953-968.

Pudi, T. I. (2007). *Understanding technology education from a South African perspective*. Pretoria: Van Schaik.

Roden, C. (1999). How children's problem solving strategies develop at Key Stage 1. *Journal of design & technology education, 4*(1).

Rowland, G. (1993). Designing and instructional design. *Educational technology research and development, 41*(1), 79-91.

Rudestam, K. E., & Newton, R. R. (2001). Surviving your dissertation (2nd ed.). Thousand Oaks, CA: Sage Publications.

Schön, D. A. (1983). The reflective practitioner how professionals think in action.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. San Francisco, CA: Jossey-Bass

Sharma, P., & Hannafin, M. J. (2007). Scaffolding in technology-enhanced learning environments. *Interactive learning environments, 15*(1), 27-46.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard educational review, 57*(1), 1-23.

Smits, R. (2000). The multiple meanings of technological practice in technology education in New Zealand. IN: Kimbell, R. (ed.). Design and Technology International Millennium Conference. Wellesbourne : The D&T Association, pp. 176-189.

Stevens, A. (2006). Technology teacher education in South Africa. *International handbook of technology education.* Rotterdam: Sense Publishers.

Swanborn, P. (2010). *Case study research: What, why and how?* London: Sage.

Waks, L. J. (1999). Reflective practice in the design studio and teacher education. *Journal of curriculum studies, 31*(3), 303-316.

Waks, L. J. (2001). Donald Schön's philosophy of design and design education. *International journal of technology and design education, 11*(1), 37-51.

Williams, P. J. (2000). Design: The only methodology of technology?

Willoughby, K. W. (2004). Technological semantics and technological practice: lessons from an enigmatic episode in twentieth-century technology studies. *Knowledge, technology & policy, 17*(3-4), 11-43.

Woodcock, C. A., Lassonde, C. A., & Rutten, I. R. (2004). How does collaborative reflection play a role in a teacher researcher's beliefs about herself and her teaching? Discovering the power of relationships. *Teaching and learning, 18*(2), 57-75.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Los Angeles, CA: Sage.

APPENDICES

APPENDIX: A1

LETTER TO THE DEAN

UNIVERSITY OF KWAZULU-NATAL

School of Education
Edgewood Campus
Private Bag X03
Ashwood
3605
20 June 2012

Prof. G. Kamwendo
University of KwaZulu Natal
Edgewood Campus
Private Bag X03
Ashwood
3605

Dear Prof Kamwendo

RE- REQUEST TO CONDUCT RESEARCH AT YOUR SCHOOL

My name is Bongeka Mabaso a student doing Master's degree in Technology Education at the University of KwaZulu Natal.

My research study is titled: ACE Technology lecturers' and pre-service teachers' understanding of the design process and its enactment in their pedagogical practice. The purpose of focusing on the design process is to explore ways in which we could enhance classroom practice in Technology Education as well as to enhance research on technological practice in the teaching and learning of Technology Education. I hereby request your consent to conduct research at your institution.

The questions that guide my study are:

1. What are ACE Technology Education lecturers' and pre-service teachers' understanding of the design process?

2. What informs and influence ACE Technology Education lecturers and pre-service teachers understanding of the design process?

The data production will be divided into two phases: Phases 1 will attempt to answer the first research question; phase 2 and 3 will address both the research questions

Phase One

This phase will aim to achieve two things: to address the first research question by eliciting the participants' understanding of the design process; and to obtain the biographical data of the participants. These two sets of data will be gathered through the use of a semi-structured questionnaire.

Phase two

Through the use of two focus group interviews, this phase will address the first research question and the second research question. However, this phase will be divided into parts. The first focus group will be divided into two parts. Part one will focus on the participants 'understanding and what informs it. Part two will focus on the graphical representation of this understanding. The second focus group aims at using literature to co-construct meaning of the design process. The participants will be assembled together in order for them to reflect together about their understandings of the design process. Participants will be interviewed at Edgewood campus

Be advised that the participation of lecturers' and teachers' is vital as it may shed light to practitioners in Technology Education as to how they can enhance their practice. However lecturers and pre-service teachers' may withdraw from participating in the study as it is voluntary. Information provided will be treated confidentially

For further information regarding this research you may contact either myself or my supervisor Dr Alant 031- 2607606(0739479893), Bongeka 031-2603413(0826787251)

Yours sincerely

Bongeka Petunia Mabaso

APPENDIX: A2

LETTER TO THE CLUSTER LEADER

University of KwaZulu Natal
Edgewood Campus
Private Bag X03
Ashwood
3605
20 June 2012

Dr M.Stears
University of KwaZulu Natal
Edgewood Campus
Private Bag X03
Ashwood
3605

Dear Madam

<u>RE- REQUEST TO CONDUCT RESEARCH</u>

My name is Bongeka Mabaso a student doing Master's degree in Technology Education within the University My research study is titled: ACE Technology lecturers' and pre-service teachers' understanding of the design process and its enactment in their pedagogical practice. The purpose of focusing on the design process is to explore ways in which we could enhance classroom practice in Technology Education as well as to enhance research on technological practice in the teaching and learning of Technology Education. I hereby request permission to conduct research at your institution. The questions that guide my study are:

- What are ACE Technology Education lecturers' and pre-service teachers' understanding of the design process?
- What informs and influence ACE Technology Education lecturers and pre-service teachers understanding of the design process?

The data production will be divided into two phases: Phase 1 will attempt to answer the first research question; phase 2 will address both the research questions

Phase One

This phase will aim to achieve two things: to address the first research question by eliciting the participants' understanding of the design process; and to obtain the biographical data of the participants. These two sets of data will be gathered through the use of a semi-structured questionnaire.

Phase two

Through the use of two focus group interviews, this phase will address the first research question and the second research question. However, this phase will be divided into parts. The first focus group will be divided into two parts. Part one will focus on the participants 'understanding and what informs it. Part two will focus on the graphical representation of this understanding. The second focus group aims at using literature to co-construct meaning of the design process. The participants will be assembled together in order for them to reflect together about their understandings of the design process. Participants will be interviewed at Edgewood campus

Be advised that the participation of lecturers' and teachers' is vital as it may shed light to practitioners in Technology Education as to how they can enhance their practice. However lecturers and pre-service teachers' may withdraw from participating in the study as it is voluntary. Information provided will be treated confidentially.

For further information regarding this research you may contact either myself or my supervisor Dr Alant 031- 2607606(0739479893), Bongeka 031-2603413(0826787251)

Yours sincerely

Bongeka Petunia Mabaso

APPENDIX: A3 AND A4

LETTER TO TECHNOLOGY TEACHERS AND LECTURERS

UNIVERSITY OF
KWAZULU-NATAL

University of KwaZulu-Natal
Edgewood Campus
Private Bag X03
Ashwood
3605
20 June 2012

Technology for All Edgewood Campus
Private Bag X03
Ashwood
3605

Dear Sir/Madam

RE- REQUEST FOR YOUR CONSENT TO PARTICIPATE IN MY STUDY

My name is Bongeka Mabaso a student doing Master's degree in Technology Education at the University of Kwa-Zulu Natal. My research study is titled: ACE Technology lecturers' and pre-service teachers' understanding of the design process and its enactment in their pedagogical practice. The purpose of focusing on the design process is to explore ways in which we could enhance classroom practice in Technology Education as well as to enhance research on technological practice in the teaching and learning of Technology Education. I hereby request your consent to participate in my study. The questions that guide my study are:

- What are ACE Technology Education lecturers' and pre-service teachers' understanding of the design process?
- What informs and influence ACE Technology Education lecturers and pre-service teachers understanding of the design process?

The data production will be divided into two phases: Phase 1 will attempt to answer the first research question; phase 2 will address both the research questions

Phase One

This phase will aim to achieve two things: to address the first research question by eliciting the participants' understanding of the design process; and to obtain the biographical data of the participants. These two sets of data will be gathered through the use of a semi-structured questionnaire.

Phase two

Through the use of two focus group interviews, this phase will address the first research question and the second research question. However, this phase will be divided into parts. The first focus group will be divided into two parts. Part one will focus on the participants 'understanding and what informs it. Part two will focus on the graphical representation of this understanding. The second focus group aims at using literature to co-construct meaning of the design process. The participants will be assembled together in order for them to reflect together about their understandings of the design process. Participants will be interviewed at Edgewood campus

Be advised that your participation is vital as it may shed light to practitioners in Technology Education as to how they can enhance their practice. You may withdraw from participating in the study as it is voluntary. Information provided will be treated confidentially.

For further information regarding this research you may contact either myself or my supervisor Dr Alant 031- 2607606(0739479893), Bongeka 031-2603413(0826787251)

Your cooperation will be appreciated

Yours sincerely

____

Bongeka Petunia Mabaso

Declaration

I ______________________________Technology lecturer/teacher at

___________________________confirm

my willingness to participate in this research. I understand the content of the document and the nature of the study.

Signature of Participant

____

Date

____

APPENDIX: B Summary of instruments

Instrumentation

The data production will be divided into two phases: Phases 1 will attempt to answer the first research question. Phase 2 will attempt to answer the first research question and the second research question

Phases	Research Question	Instrument	Rationale	Descriptions of what is designed to measure	Who developed it?	The types of items on the instrument	How is it scored?	Validity and reliability of the instrument
1	What are Technology Education lecturers' and in-service teachers' understanding of the design process?	Semi-structured questionnaire	To elicit Lecturer's and in service teacher's understanding and biographical data for research question one	The instrument is going to measure lecturers' and in-service teachers' understanding of the design process	Part of the instrument has been adapted from Cohen and Manion (2011)i.e multiple choice and open ended questions have been self designed	Teaching experience, academic qualification, subject /content knowledge, informative workshops attended	Multiple choice Open ended(w ord based)	The questionnaire will be piloted so as to minimize factors that minimize validity and reliability such as wording of questions.
2		Focus group narrative and graphical	To allow for group reflection based on the analysis of responses from phase one of the research. This is to allow the practitioners to reflect about their	This is to measure understanding and what informs it as they reflect about their practice and coming to an understanding that learning occurs in a participative framework	Self designed	Validation of preliminary understandings of the design process Graphic - Relationship between design and problem solving	Multiple choice, table and descripti ve response s	The participants chosen would have some sort of similar background in the area that is the focus of the study.

			understandings of the design process and make meaning among themselves rather than individually (Barbie & Mouton, 2007)					
		Second focus group	Collaborative understanding of the design process	This is to measure understanding and what informs ACE lecturers' and teachers' understanding.		Descriptions of the design process from selected scholars who have written about design Co-construction of meaning of the design process through participative engagement Establishing a participative framework for understanding the design process		Ensuring that the interview is as informal as possible so participants can feel comfortable to participate. Transcribed data will be verified by the participants

W.r.t. Situated learning the following are important:

Understanding about learning and learning through design

Firstly, learning is understood as a social process which involves co-construction of meaning through active participation and shared understandings. It is the creation of an individual's identity which is formed by participating in a technological design activity in association with others that constitutes learning (Lave & Wenger, 1991). Secondly, learning through design process is enhanced by the creation of authentic learning experiences which have some value and meaning for the learner (Lave & Wenger, 1991). This involves extending the learning experience beyond the Technology classroom setting into a wider community.

Situated learning is not possible without some degree of reflective practice

The data production

The research focus of the study is to explore technological practice. In this section the methods used to collect data are described. In order to obtain in-depth data the study will use a variety of methods to answer the two research questions. Babbie and Mouton (2007) state that qualitative research provides in-depth and detailed descriptions of meanings and actions as it features multiple methods of data collection (triangulation). The data production will be divided into two phases: Phases 1will attempt to answer the first research question, phase 2 will address the first and second research question.

Phase 1

Research Question 1: What are ACE Technology Education lecturers' and in-service teachers' understanding of the design process?

This phase is twofold as it addresses the research question mentioned above by eliciting the participants' understanding of the design process; and obtaining the biographical data of the participants. These two sets of data will be gathered through the use of a semi structured questionnaire. The rationale behind using the instrument is to measure the practitioners understanding of the design process. The questionnaire will consist of items such as biographical information as well as subject/content knowledge. Cohen et al. (2011) argue that the validity and reliability of a questionnaire is threatened by the wording of the questions or design .The questionnaire will be piloted so as to minimize factors that minimize validity and reliability such as wording of questions. The instrument will require relevant issues to the study.

Phase 2

Using two focus group interviews this phase aims to address the both research questions one and two. The first focus group will be divided into two parts Part 1 focusses on the narrative aspect of the participants' understanding of the design process and what informs it. Part two focuses on the graphical representation of this understanding. The second focus group uses literature which aims at arriving at a collaborative understanding of the design process of ACE lecturers 'and teachers'. However, the participants will be assembled together in order for them to reflect together about their understandings of the design process. This will enable them to reflect about their practice and coming to an understanding that learning occurs in a "participative framework"rather than in the mind of an individual (Lave & Wenger, 1991).

APPENDIX C

Self-Administered Questionnaire

1. What teaching qualification/s do you have?

Qualification	**Year**	**Majors**	**Institution**
Doctorate			
Masters			
Honours			
Post Graduate Certificate in Education			
Degree			
Other:			

1. Do you have any training in Technology Education? Tick the appropriate box:

Yes	No

1. If yes, please indicate the institution, the duration of your training as well as the phase.

Institution	**Duration**	**Phase**

2. Indicate which of the following events you have attended in Technology Education:

Type	**Year**	**Theme/Content (i.e. assessment)**	**What were your observations?**
Workshop			
Conference			
Seminar			
Other: ………………..			

3. Please indicate your experience in teaching Technology Education.

Technology Education teaching experience	**Number of years**
Intermediate phase(Grades 4-6)	
Senior phase (Grades 7-9)	
Higher Education	

4. Some Technology Teachers use the terms ‘design process’ and ‘problem solving’ interchangeably. What are your views on this? Please elaborate on ***your understanding*** of the design process in the space provided below.

PARTICIPANTS' RESPONSES FROM QUESTIONNAIRE - QUESTION 6

APPENDIX C 1

PARTICIPANT 1

Row	Question	Focus	Response	Analysis
1	What are your views on people's interchangeable use of DP and PS by teachers? Please elaborate on your understanding of the DP.	**Definition of DP**	Design process is a process of finding a solution to a need. DP is much more than PS, it is a systematic way of solving a problem.	DP=PS DP>PS
2		**DP "practice"**	More than thinking about a problem; Team spirit where learners engage in the following activities:brainstorm ideas,drawing,annotations,weighing up options,investigating exixting products Evaluation of own product	DP process>PS process DP process = collaboration covering 6 aspects DP process = appraisal
3			Critique themselves and commend their work	DP=commendation

APPENDIX C 2

PARTICIPANT 2

Row	**Question**	**Focus**	**Response**	**Analysis**
1	What are your views on people's interchangeable use of DP and PS by teachers? Please elaborate on your understanding of the DP	Interchangeable use of DP and PS	DP and PS shouldn't be used interchangeably	DP≠PS
2		Definition of PS	PS is a more generalised process	PS = general process
3		Definition of DP with the emphasis on formation and modification of the made environment	DP is a specific process which entails a process whereby the made environment is formed and continually modified.	DP = specific process

APPENDIX C 3

PARTICIPANT 3

Row	Question	Focus	Response	Analysis
1	What are your views on people's interchangeable use of DP and PS by teachers? Please elaborate on your understanding of the DP.	Definition of DP The respondent starts with the second part of the question, i.e. her understanding of DP Definition of DP	Design processes are stages followed through problem solving.	DP= stages used for problem solving DP = PS stages
2		DP practice PS practice	5 stages are involved: Investigation Design Making Evaluation Communication	
3		There are multiple ways of solving problems	When there is a problem, there can be a solution/ multiple solutions	Problem=solution/s
4		The role of investigation within PS	In a process there can be solutions that were previously used in a similar problem therefore investigation is done. After investigation or during investigations designs for solution are made, followed by making. After making solutions are evaluated then communicated to the public. If solution failed during evaluation redesigning and making occur	Investigation done =new solutions required to a problem
5		Practice after/during INVESTIGATION	After / during investigation DESIGNS FOR SOLUTIONS ARE MADE followed by MAKING EVALUATION COMMUNICATION	DP=linear
6		Practice during EVALUATION (Engagement in design process)	During evaluation redesigning and remaking occurs when a solution fails	DP=iterative in two stages

APPENDIX C 4

PARTICIPANT 4

Row	Question	Focus	Response	Analysis
1	What are your views on people's interchangeable use of DP and PS by teachers? Please elaborate on your understanding of the DP.	Views on people's interchangeable use of DP and PS	Thin line separates DP and PS	DP is more or less the same as PS
2		Definition PS	Result of intervention in finding a solution to a problem	DP=intervention
3		Enactment of DP by fellow teachers	Teachers use stages of DP in problem solving without considering them as a suggested process to follow	DP guides PS

APPENDIX C 5

PARTICIPANT 5

Row	Questions	Focus	Response	Analysis
1	What are your views on people's interchangeable use of DP and PS	Definition of DP	Formation of a plan to help designer/learner to devise a solution **OR** an activity of determining the workflow, equipment needs and implementation requirements for a particular process	DP=plan to devise a solution
2			Activity of determining the workflow, equipment needs and implementation requirements for a particular process	DP=Activity to determine workflow
3		Tools of the DP	DP as an activity entail using a variety of tools i.e. research simulation/modelling, drawing, scale drawing and models	
4		Emphasis is on the **cyclical nature** of the process foregrounding EVALUATION	DP is not linear but usually cyclical and **evaluation** takes place throughout the process	DP = iterative process
5		Practice and attitude to the process of **EVALUATION**	A solution to a problem always has a room for improvement as Technology is ever changing.	**ADAPTATION -** Room for modification of solution

APPENDIX C 6

PARTICIPANT 6

Row	**Question**	**Focus**	**Response**	**Analysis**
1	What are your views on people's interchangeable use of DP	Definition Understanding of the two concepts	DP is much more than problem solving	DP>PS It is not similar to PS
2		Nature of the DP	DP is used to encapsulate the actions taken by technologist/learner to design or make an object to meet need/want	Actions to design and make objects that meet a need or a want
3		Activities involved in DP	It entails: investigation, trying out, experimenting, making, constant communicating, coming up with new ideas & always designing & adapting	The actions are diverse - both physical and mental
4		What informs DP	DP draws on all the "technologist" knows & beyond into the future	
5		Iterative nature if DP	It is not linear but an iterative process	DP ≠linear, but iterative.
6		Classroom constraints	however in the constraints of the classroom there will be "a moment when the task is initiated & a moment when it is brought to a close"	
7		The role of Technology education?	Hopefully "the learner will be then sufficiently motivated to move on even outside the boundaries of the classroom"	Learners can apply DP beyond classroom

APPENDIX C 7

PARTICIPANT 7

Row	Question	Focus	Response	Analysis
1	What are your views on people's interchangeable use of DP and PS	Definition	DP is an approach-to solve a problem	DP = approach to PS
2			It is a way used by technologist/designers to tackle a problem and look for solutions	DP=way / strategy
3		Practice	Activities' involved in DP are research, experiments, looking at existing products, observation, interviews& surveys designing	DP=variety of activities
4		Enactment and understanding of Design by the other	Design is often limited to drawings. There is an **over-emphasis** on correct technical drawing skills.	Understanding of DP limits design to formal drawing
5		Call for a broader understanding of DESIGN as trying out things	Designing can be just trying things out with a piece of material	Designing = trying things out (e.g. prototyping)
6		Drawing on personal experience	When I design this is how I do it, sometimes with few rough sketches It is at the very same stage that I evaluate-if product work or not, I will make and evaluate again to see it working	DP=evaluation
7		Drawing on teaching experience	In a group context – communication takes place through out	Communication is key in group scenarios
8		Description of her understanding of DP	DP is not linear and it should not be prescribed for learners	DP ≠ linear process DP shouldn't be prescriptive
9		Drawing from her teaching observations	Learners do not enjoy the formal drawing and planning, they prefer to learn and solve the problem through trial and error	Learning and PS should be done through trial and error

APPENDIX C8

RESPONSES TO QUERIES BASED ON QUESTIONNIARE

(Written Responses)

Researcher- R Participant- P (1, 2, 3, 4, 5, 6, 7)

R: Design Process is not equal to problem solving explain.

P1: Design Process is not equal to problem solving. Problems are solved through the design process therefore DP, problems will not be fully solved.

R: Clarify what it means to be systematic in your response.

P1: DP is systematic. This means that there are specific steps that must be followed i.e. Investigation of existing products, drawing a design to suit the need at hand(either modelled against an existing product or something entirely new). Making is another step where the design is “tested” so to speak. At this stage the designer is not entirely sure that his design will work. It is only after the model has been made that one is sure that the design works. If not the steps are re-followed. I say systematic because one can assume what the designer will do next .PS is simply thinking about a solution and coming up with something No appraisal or evaluation. DP is a long process involving, head, hands and emotions. Not just head.

P1: It’s not easy to differentiate between PS and DP but I must stress that PS is not equal to DP. DP is a process which takes place within the process of problem solving DP draws on creativity, skills and craftsmanship, emotions of the maker/designer. PS on the other hand is merely providing a solution.PS deals with WHAT”,DP “HOW”

P1: Problem solving is itself a process whereby a solution is to be found to a problem. Hence it deals with the question “What should we make?” The DP deals with the question How should we make it? For example; A library is built. It needs furniture. The library users need to be able to sit. This is the problem that has to be solved What should we make? The solution is chairs. Now the design process comes in because a specific kind of chair for a specific purpose/function must be created. A design made up and a chair is created around this design brief. Hence problem solving is providing a chair- any chair but DP is creating a specific kind of chair for a specific purpose.

R: Clarify what you mean by “more than thinking about the problem”

P1: DP draws on a lot more than just simply providing something to sit on. DP provides a specific kind of a chair to perform a specific function i.e. seating in a library. Whether or not the designer is aware of the 5 steps in the design process (as I’m sure they were not in indigenous times), unconsciously the steps were still followed. As long as there is a design brief or factors that must be included in the making of the product the DP steps will be followed. These steps not necessarily be followed in any particular order but they will be there. It would also add that PS, for me is the “force” that drives DP The design brief is also a “force” that drives the DP to move in a particular direction. Without. PS there can be no DP.

P2: PS is” generalisable”in that it can be applied in any discipline and in many daily

contexts (e.g. finding out how to get from home to a holiday destination).
R: Clarify what it means by the statement: the made environment is formed and continually modified.
P2: The "made environment" or" the material culture" is a manifestation of man's historic and ongoing attempt to shape the landscape (exploit the natural world) so that it serves his needs and interests. This process "shapes" or "modifies "the natural landscape.
R: How do we engage in this multiple way of solving a problem?
P3: My argument was there can be multiple solutions to a problem. E.g. cell phones. The choice of a solution will be based on the functions in that solution. Each person looks at which functions suits him/her the best and choose
R: What is the role of investigation?
P3: Investigation leads us to discovering approaches to our PS. Existing solutions are if investigated and also through investigation one can be directed to different approaches these are existing solutions.
R: What do you mean by design in your statement after/during investigation?
P3: I meant to say that designing a solution can be done during investigation e.g. in Case studies, one can do designs to her /his solution whilst doing the case study. During investigation you can formulate/design your approach to a problem.
R: What is this line? Can you elaborate on this? So, what separates the two?
P4: Thin line: DP can be applicable to another situation after evaluation while SP doesn't extend to evaluation may not be adapted to another situation.
R: How do we intervene: What do we do?
P4: By provide calculated solutions.
R: Teachers use stages of DP in problem solving without considering them as a suggested process to follow. Analysis is DP guides PS. Please elaborate on this statement.
P4: Guide lines. DP is regarded as a linear approach to the identification of working solutions. Learners are not encouraged to develop related skills in an alternative way. Interchangeable use of DP and SP: Teachers feel that when they approach DP, they are solving a problem.
R: I need clarification, w.r.t. the statement. Are there 2 definitions or only 1?
P5: Design Process: my definition of the DP is only applicable to the man-made (contextualization) world where solution to problems (invention or improvement) from emanates limited either unforeseen circumstances or limited knowledge.
R: DP is much more than problem solving please elaborate
P6: DP is more than problem solving however it does incorporate problem solving in the sense that as throughout specific challenges will emerge and have to be dealt with Design suggests the solution will have to be tailor-made, aesthetically pleasing, take ethics and cost etc. into consideration
Me: Actions to design and make objects that meet a need or a want
P6: confirmed.
R: The actions are diverse - both physical and mental. Clarify the differences between: Trying out and experimenting. Designing and adapting
P6: The first is mainly physical whilst the second is mainly cognitive. However they are symbiotic in that one will inform the other.
R: Clarify: Is it present and future knowledge that informs the DP?
P6: Yes present and future knowledge informs D.P. The designer is inspired by what he knows but also challenged to go beyond what he/she knows and seek new knowledge and skills to design a superb product.
R: Unpack the statement: "a moment when the task is initiated & a moment when it is brought to a close"

P6: A teacher has to be practical as he/he has constraints. Each lesson has to start at a to specific time in a specific place and finish at a specific time. The teacher has to tailor her idealism within these and other constraints and somehow enable design and technology take place effectively.

R: Hopefully "the learner will be then sufficiently motivated to move on even outside the boundaries of the classroom" Unpack the statement.

P6: A motivated teacher/ and teacher-mentor will continue 'designing" and "researching" etc. Beyond the classroom and its constraints. After hours the "D.P" will continue in thought and deed".

R: Clarify the difference between "tackle a problem and look for solutions"

P7: I feel this statements are the same tackle problem=look for solutions

R: DP= variety of activities clarify.

P7: DP includes research, experiments, looking at existing products, observation, interviews and survey, investigating, designing (draw, trial and error or prototypes).Evaluating and communicating.

R: Understanding of DP limits design to formal drawing. Clarify on which the other is?

P7: Other curriculum developers and teacher training on TD originally.

APPENDIX D

FOCUS GROUP INTERVIEWS

Phase 2:

According to Cohen and Manion (2011) focus group interviews are forms of interviews which are based on the interaction within the group, discussing a topic supplied by the researcher yielding a collective rather than an individual view. In addition, Babbie and Mouton (2007) argue that focus group interviews serve to shape and reshape opinions about the topic at hand. In this study, two focus group interviews are used to “shape and reshape” the ACE Technology lecturers’ and teachers’ understanding and what informs their understanding of the design process in order to arrive at an individual participative framework for understanding the design process. As argued by Lave and Wenger (1991), it is the creation of an individual’s identity which is formed by participating in a technological design activity in association with others that constitutes learning. As mentioned earlier, situated learning as a conceptual framework, is used in this study to give a better understanding of learning and learning through design. In considering the ACE Technology lecturers’ and pre-service teachers’ involved in this study as a community of practice, learning within a community of practice as provided by the focus group interviews, is thus understood as a social process which involves co-construction of meaning through active participation and shared understandings. It is in this regard, that this phase is divided into 3 parts:

Part 1: Validation of preliminary understandings of the design process

The aim of the first part is twofold:

- To validate the data gathered in the questionnaire;
- To validate the interpretation of the analysis done by me on the information gathered through the questionnaire.

Part 2: Graphic Representation

The aim of the second part is:

- To use graphics in order to depict the ACE Technology lecturers’ and teachers ’understanding of the design process.

Part 3: Co-construction of meaning of the design process through participative engagement

The aim of the third part is:

- To use the literature and the ACE Technology lecturers' and teachers' understandings to come up with a collaborative understanding of the design process.

Part 1: First Focus Group-Validation of preliminary understandings of the design process

In this section, I will present the first (preliminary) analysis of the questionnaire responses to the research group. This will be followed by a discussion which will validate the data gathered as well as the analysis thereof. In validating the above, the following questions will be asked:

- Do you feel that the presentation captured your ideas adequately? Yes/No. Elaborate.

- Do you agree with how your ideas were interpreted? Yes/No. Elaborate.

The above discussion will allow us to arrive at the second level of ACE lectures' and teachers' understanding of the design process. The session will be video recorded. The table below will be drawn up to help with the analysis of the above two questions:

Table 1: Validation of participants' ideas

Capturing of ideas adequately	Confirmation of researcher's adequate capturing	Other

Table 2: Validation of researcher's interpretation

Researcher's interpretation	Confirmation of researcher's interpretation	Other

Part 2: Graphic Representation

This part used graphics depict the ACE Technology lecturers' and teachers 'understanding of the design process

Part 3- Second Focus Group – Co-constructing meaning of the design process through participative engagement.

The aim of the second part is to use the literature and the ACE Technology lecturers and teachers' understandings to come up with a collaborative understanding of the design process.

The researcher will use scholars who have done research and have written on the design process to co-construct meaning of the design process with the research participants. This session will be video recorded.

Researcher's interpretation	**Researcher + research group interpretation**	**Literature understanding**	**Co-construction - Research group's understanding as influenced by the literature**
		According to Schön(1987) design is a 'reflective conversation with the situation'	
		Eggleston (1994), states that the design process is describing, analysing and improving human activity that lead to end products and services.	
		According to the APU(as cited in Banks 1994) design, "it's an active process involving pursuit of a task that results in improvement in the made world"	
		McCormick(2000),states that problem solving and design process are forms of knowledge of how to proceed	
		Roberts (1994), Hill (1998), Roth, Tobin and Richie (2001) design has iterative patterns involving processes of conscious reflection and thought.	

Part 3 – Establishing a participative framework for understanding the design process

The aim of this part is to establish an individual participative framework (established from each research participant) for understanding the design process. The following questions will guide the discussion.

1. What have you learnt from participating in this focus group? What is your understanding of the design process now?

2. Has it changed from your original understanding? Yes/No. Elaborate

3. In terms of what was discussed in part 2 regarding the different frameworks for understanding design, which frame would you say better reflect your understanding? Explain.

4. Which framework would you use in your own practice? How? Why?

5. Do you have anything that you'd like to share with the group?

APPENDIX D1

FIRST FOCUS GROUP INTERVIEW - PART 1

THEME- Part 1: Validation of preliminary understandings of the design process
Date – 7 November Edgewood Campus Room –G-210
Researcher- R Participant- P (1,2,3,4,5,6,7)

The session started by welcoming everybody. I then introduced my study by eliciting the title, research questions as well as data collection phases. The aim was to refresh the participants' memory about what is encapsulated in my study. The procedure of the day was outlined as follows: Present the findings at an individual level;
In validating the findings, the following questions will be asked:
Do you feel that the presentation captured your ideas adequately? Yes/No. Elaborate.
Do you agree with how your ideas were interpreted? Yes/No. Elaborate.
Participants will have to do: Confirm interpretation of data; Respond to the queries/comments raised by the researcher; Optional: additional comments to question posed in the questionnaire (i.e. Question 6).
I presented my findings at an individual level and stating my analysis. The way that data was categorised was explained. To make the process of validation easy participants were given copies of their questionnaire as well as a table consisting of the interpretation, analysis. In validating the interpretation participants were guided by the questions mentioned above. Some participants were not clear as to what to do regarding validation, which was explained further. Participants were given time to respond to the questions that guided their validation. Further they had to respond to the comments I had to clarify their points regarding the question. After writing their comments an open discussion was held.

Confirmation of data- Open Discussion

P2: in your analysis on the comment I made about design process used interchangeably with problem solving you reduced your analysis to very useful idea...I think the equation that DS is not equal to PS. Design process is not the same as problem solving and I think that is a correct analysis however in saying that it would be a mistake to understand that in a way which suggested that they were not similarities between the two.

P6: interjects: I had the same thing here.
P2: So I am saying yes I agree they are not the same, and I think your analysis is correct but one must not understand that to mean that there is no similarity.
P6: So its meaning they are not they are not synonymous but there are common…..
P2: They are not the same
P6: You can't just swap the words but some aspects of problem solving do occur in Technology.
R: Give us the data that says it is not 100% correct to say DP is not equal to PS
P2: I would be more inclined to think that this might be represented more like a Venn diagram rather than DP not equal to PS.
P2: I'm not sure that am qualified to really to give the answer here cos I have not thought about this much but there are similarities I would think if you took PS like that and you took design now I think the danger with what you stated and it's not wrong is that you could see DP here and say ok they are not the same but there are similarities so perhaps these things need to kind of overlap

P2: The problem I have is just where I would. how far I would make there are definitely similarities and one needs to explore that at the moment I would say the traditional one is kind of tends to make it looks like this is probably what I'm thinking about at the moment where you start saying well ok there is similarities but they are not the same thing

P6: Would you say then there have certain things in common that there are other aspects that are not common

P2: It's quite difficult I'm actually, I think this actually almost needs some serious thought some people might put PS inside the DS you know completely inside the DS and say it's kind of subcomponent

P6; Would you not say will it not depend on the actual approach to teaching the way you and look at learning and the way look at … of technology will affect the way you view the DS how you would do the Venn diagram. I think the way you look at the DS is also affected by the way you look at teaching and learning. I think different people approach teaching in a different way some people like everything to be organised so that no surprises spring up another type of person has a much looser framework because that's the way they teach and it's not tightly planned before hand and I think that would affect the way you drew your diagram.

P2: I don't want to argue to this but there are two things here there is a relationship between let's say pedagogical styles and how technology might be taught

P6: That's what I'm trying to say

P2: I think you must be careful here what drives what? On one end you got the discipline

P6: One could almost say ones personality ehmm it works both ways .Your personality almost has an effect on the way you view the DS and the way you teach. That's what I have been really starting to think about

P7: And maybe the way you yourself design. Because we do approach things differently and if you state different designers they have different approaches so maybe when you teaching you do more[ ] or else if you have not really sat down and designed yourself maybe you are more bound by the curriculum that kind of then describe the DP that we do it this way so I think that also plays a role to the way you approach the DP.

R: Can you be more specific when you talk about different designers approaching the DP in different ways. Give us just one example that we understand what you are saying.

P7: Nash the SA designer he doesn't he didn't study formal design he just pick up bottles and looks at them and start cutting and snipping until he has made something so that would be like his personality and his approach if he had to go into the classroom and actually teach he would probably do the same with learners maybe tell them to just try this up pick this up see what you can do because that's what he himself does whereas maybe somebody who has never really engaged with designing themselves just teacher, might rather say ok we have got to kind of all follow the steps or let's all draw let's all investigate and kind approach design that way. What I'm saying is it depends have you actually done technology yourself have investigated have you created have you designed or are you just teaching?

P2: Let me ask a question when you say it all depends, what all depends?

P7: Where did I say that?

P2: At the beginning you said it all depends on the person who is teaching what all depends?

P7: I was going with Mary speaking about your approach to teaching that's where I was following right on if we have to go back to what we were saying about the actual difference between DS and PS and I was also kind of thinking that when we were discussing that it also depends on your reading and your qualification in a way and how much academic experience you might have because the word PS is very different depending on what you reading so if you just hear the word PS and you haven't done any kind of academic reading on it then in a way it is DS because you are trying to solve a problem but if kind of look at ok let's go back to the original founders of PS method and methodology then it also going to change your picture of what DS is and what PS is.

R : Let us not forget the main question is people trying to respond whether their interpretation was done adequately.

P2 was still explaining that there are commonalities the two is it? so we cannot just separate PS from DS.

P2: Ya I wouldn't think that one could argue too strongly for a case where these things were completely separate

P6: There isn't YES or a NO (interjects)

R: So it is my analysis which summarise that PS is not equal to DS that you are not happy with

P2: No I am happy because they are not the same but I think that somehow one has to just remember that although they are not the same there are commonalities

P6: So you qualify that

P1: I just want to come back to that question .I'm not sure who asked it WHAT DRIVES WHAT? Is PS drives DS or what drives what. I would think that the DS takes place because of the problem Is that right? Without the problem no DS I guess

P6: But yet people just want to design for love and creativity so to me…

P1: That's exactly what brings me to agree with P2 in saying that Designing is not really PS because it doesn't have to be a problem in order for DS to take place

P6: but it can be you see that is why I say that designing is much more than PS there is a problem that needs to be solved or there is a need or desire or whatever I suppose I just have (……) may be PS to me is like say is so rigid and the DS is so creative and uplifting and relieving. You see Tech that the wonder of that it embrace (……) I think in the CAPS doc they have not captured that aspect of Tech sufficiently.

P4: I think it would be difficult for us to say what drives what all I can say on my personal perspective is that in classes when people are talking about problems they are only aligning it to Mathematics and immediately you say PS they bring in the issue of mathematics and calculations whereas in Tech when you talking about PS not always the case that it's a problem sometimes it' becomes a need then a need to be addressed maybe we talking about design in different direction maybe a designer designing a dress for a specific function there is a need maybe there is a problem around community a person is designing to address the need in the community or to solve the problem in the community What I observed is that when they are engaged in this designing some people will follow the DS as it is maybe because they are afraid of the calculation that might crop in as they are designing and they will avoid anything to do with PS because it reminds them of mathematics as the lady was talking about the personality when a person is not clued up with mathematics he will avoid anything that has to do with calculations and in the area of modify to come up with a new solution. All in all a DS and PS may differ but driven by personality of a teacher who is supervising or facilitating the teaching in the Technology class .

To me we may end up coming with a new word or terminology instead of PS because that on its own separates the people according to their personalities in relation to calculations and problem solving.

R: can you please summarise what you have just said in three lines so that we understand the gist what are you getting at.

P4: What I’m trying to say here is that PS will only be limited to a problem or a need but DS will extend to investigation it will extend to evaluation whereas other people will look at PS as the provision of a solution for a particular problem without Evaluating whether the problem it can be applied or adapted to another solution

R: What do you think?

P4: My thinking is that there similarities and there are common areas that need to be linked for the PS and the DS to be effective for the thought processes.

R: People are talking about models and I’m seeing people drawing. Can you Just drawing. How do you see this relationship between the two

R: Second part participants were required to do graphic representation

APPENDIX D2: Focus group interview - Part 2

SECOND FOCUS GROUP INTERVIEW: PART 2- 30 NOVEMBER 2013

<u>Room: FH111</u>

<u>Validation of Participants understandings of the design process:</u>

The researcher started by welcoming the participants and presented the schedule of the day. Participants had to validate the researcher's interpretation about the understanding of the design process. This validation aimed at answering research question one. In addition clarify the drawings that they drew with regards to the relationship between DP and DS. Furthermore read literature to come up with a collaborative understanding of the DP.

The researcher asked the participants to clarify what the participants meant by :

1. **Problem Solving as a general process**
2. **Design process as a specific process**

P 6: What is the context here? When it says problem solving is viewed as general process.

Are we talking about it in a context of education or in a context of life?

R: In an educational context.

P1: I'm thinking maybe when that statement was made it was taken that PS takes place in all spheres of life with that the education it doesn't matter….but not all PS requires design I don't know I have forgotten the context that it was said.

P2: I think it's quite important that we to clarify this it is quite likely that people responded to this question about similarities and differences between DS and PS there is different assumptions about ……….(not clear)

P6: Because you can either think that it is in the classroom or in life and it can affect your answer.

R: I took them back to the initial question from the questionnaire how the question was phrased.

P1: You know I think the second point is something I could have said the specific reference to the five different stages that are involved in the DS I think perhaps that's why the word specific because it would involve different processes although not always in the same order or as you said but there are still five clear stages that can be identified. I think that's why the word specific

P7: Just got to watch the words of steps or stages in that bit certain responsibilities or aspects that you do kind of identify, there are those certain responsibilities that you would like to cover in DS.

R: So you say its specific because there are these activities or actions

P7&6 : or elements

P7: Ya just looking for that word

P2:Ya probably there is a relationship between DS and what you call elements, stages PS when… In common conversation about design if you are talking design…what field is being implied I would think that design is mainly something that is focused on the made environment, it's the buildings and the… the systems and products, sees emerging around you …also obviously it relates to IT…and perhaps all that kind of stuff perhaps you can diminish the fact that design seems to be focused around productivity…. this issue of whether we should use the words like steps or stages….There are differences between stages and steps .Steps very much suggest you go from one thing to the next in a linear way one stages perhaps would be more overlap or….

P6: It does seems to suggest that you pass through these stages, just as you talk about final stage when you come to practice you can hold fancy beliefs that it's like being iterative when you to practice you can believe that but the constraints of your classroom can mean that you revert you back to something more linear and so I'm quite interested in how one could under the constraints of a large class and….and things like that how you can actually do this iterative process in a true fashion not just go back and research but actually everyone is free Ray want to start with certain pace, I want to do this and that is something else. Although we may hold this view we are constrained within our classroom so I would see class would be the actual context that teaching also affects your practice

P2: But practice here that is spoken about is education practice

P7: Are we looking at classroom teaching here because I mean that is a very real problem your understanding we be totally its…. you have wonderful ideas how you would love to do it but you are limited by curriculum and you are limited by assessment. You have to have something to mark at the end of the day so you kind of guide the

P1: I totally agree with you

P2: But isn't this the real professional teachers that we need navigate….. because when we say practice she is talking educational practice rather than the real life practice the constrains and difficulties of educational practice may mean that design in classroom doesn't look exactly like what design looks in practice in professional studios but I would say for teachers if we are wanting to teach design surely the real challenge for us is how can we make our classroom and what happens in our classroom more authentic in terms of making it more like what a real design in the studios and that's where these constrains for me need to be circulated and debated because they will be difficulties in doing that but you see if we simply given to the fact that there are problems in the classroom then what you will be teaching in the classroom is never going to be the same as what these people and these children's ultimate in real life and here lies the problem.

R: As a teacher you understand what design process is but your practice will be different because of the constraints

P6: it(practice) may not reflect your true view of design you will try to meet all the changes and make it as free and exciting as possible that there are constraints and therefore parents want to see a product but we also need to inform others that the process is important as the product that its actually coming out from the ideas and innovativeness that's important but practically the headmaster and everybody else wants to see a product and preferably not a scruffy one.

R: Let's look at the definition from literature. Read the extracts. From the extracts can say your understanding has changed?

P2:Can I ask a question though about this Annamarie Hill article because if you read the tittle it appears she is talking about PS of a particular kind here as an alternative to design but when you read the article it really appears to me as if that this PS she is talking about is the design that most people in this group here are talking about the non-linear iterative process.

P7: Ya I actually like I'm familiar with it because I have been using her for my own

Research whole idea of actually picking the real life problems where can and I think having that setting genuine problem to be solved can bring .So I actually had an opportunity of doing that in my school designing their want, design a school jungle gym for the media center and we put it in context they did build a model which is media center and we put it in context they did build a model which what I assessed along how they worked through the design process but it really made a difference in sought of context. It took two terms (8wks). There were limitations though.

APPENDIX D2: Focus group interview - Part 3

PARTICIPANT 1

SECOND FOCUS GROUP INTERVIEW: Theme- Co-construction of meaning and establishing a participative framework

1. What have you learnt from participating in this focus group? What is your understanding of the design process now? Has it changed from your original understanding?

I learnt that there are many different views of what the design process is. Problem solving is not exactly the same as design is also what I learnt. I learnt that design does not have to be linear (as I had previously believed) but I agree that the policy leaves very little room for freedom of creativity. In that sense my perception of the design process has changed. However, I still do not completely agree with the view that the design process drives problem solving. Granted, there have been inventions that have been stumbled across without there having been a problem pertaining to that invention that needed solving but those are few and far between. I am still of the view that problem solving drives the design process because the problem dictates *what* has to be designed but not necessarily *how* it is to be designed. That is up to the creativity of the designer.

3. In terms of what was discussed in part 2 regarding the different frameworks for understanding design, which frame would you say better reflects your understanding? Explain.

I believe that the frameworks which describe design process as involving describing, analysing and improving human activity that leads to end products and services and that design has iterative patterns involving processes of conscious reflection and thought about the problem that needs to be solved in the made- world best describe my understanding.

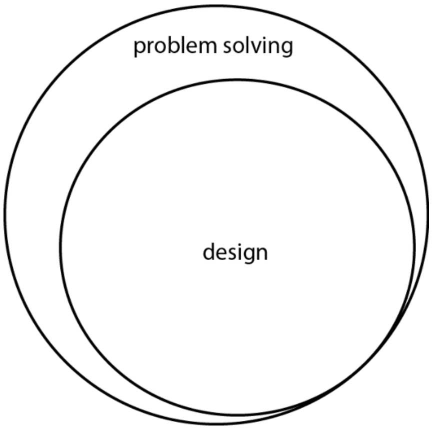
4. Which framework would I use?

I would use Eggleston (1994). I would require my learners to investigate existing products that relate to the problem to be solved. They would also be required to design using talking, drawings to get them to be able to express themselves. The difference is that I will try as far as possible not to dictate the stages of the design process. I understand that this will not be easy given the restrictions placed on us, Technology teachers, but it is worth a try so that the learners do not become bored. 2014 will be the first time that I will be implementing the CAPS Document and it will be a challenge to capture and maintain the interest of the learners throughout each term.

PARTICIPANT 2

1. **What have you learnt from participating in this focus group? What is your understanding of the design process now?**

The focus group has provided a useful opportunity to reflect on the similarities and differences between Problem Solving and Design. In this regard, I would say that my earlier diagrammatic representation of this relationship has changed and would now look more like the following:



Also, it is really worthwhile to work with others on a topic of this kind because it provides an opportunity to explore the assumptions and issues that motivate their view of design. Without this it is easy to imagine that other people are informed by the same factors that shape your conception of this process.

2. **Has it changed from your original understanding? Yes/No. Elaborate**

Yes, in the sense that designing is not an easy thing to describe and one's understanding of it grows.

3. **In terms of what was discussed in part 2 regarding the different frameworks for understanding design, which frame would you say better reflect your understanding? Explain.**

First, it seems clear that most researchers who question the "linear" approach to teaching design are questioning the common model of the design process that appears in many school policy documents. In this respect research papers like those quoted in part 2 above are limited in that they only point out the problems and inconsistencies of the "linear" approach. They seldom (perhaps with the exception of Kimbell) make any attempt to suggest what an authentic approach to teaching design in schools might look like.

This is probably the reason why so many practitioners (despite the critical research) nevertheless continue to use the "linear" approach. They know it is questionable, but it is the only one that appears to work in schools.

Schon's work is important for a different reason. He is dealing with problems related to the teaching of design as part of the training of design professionals (in professions like the performing / visual / musical arts and architecture). The process of teaching design in such institutions (studios) is not questioned because it is "linear" – it is questioned because it does not conform to what the academic research institutions consider to be an appropriate method of training professionals. Its academic rigour and status are questioned. In his paper he therefore analyses the so-called "studio" method of training and considers what it can (and cannot) contribute to the teaching of professionals in academic research institutions. Schon is therefore probing the underlying assumptions, prejudices and limitations that exist within the broader academic community regarding the way in which professional training is conducted in the arts and architecture. His analysis forms part of the wider "political" struggle to define what counts as authentic education.

To answer question 3: Although it is correct to question the "linear" models of design used in most school education policy documents, it is true that some structure should be evident in the process of teaching design in schools. I think the APU research material offers a possible approach by breaking the design task into stages which are not defined in terms of specific skills (like investigate, plan, evaluate, make etc.) but rather in terms of what work needs to be completed. For example:

Stage 1: Understanding the design problem and identifying design issues.

Stage 2: Generating design ideas and developing prototypes.

Stage 3: Refining the design and making a test prototype.

Stage 4: Testing, refining and perfecting the design.

4. Do you have anything that you'd like to share with the group?

Finding ways to teach design skills authentically in schools is important for all the reasons given in the research papers cited here and in the growing body of research material on design education. School education is shackled to an outmoded academic model of teaching and learning which (in its better forms) has some value in the FET Band and in Higher Education. However, its value (particularly in the GET Band and often in FET) is often limited and of little relevance.

Children have bodies as well as brains and education should employ both in a balanced way to prepare them for life and learning. At present there is an undue emphasis on "brainwork" in schools and (as a result) they are often sterile and dull. Design begins to open up ways of restoring the natural balance between thinking and doing that should be at the core of school life and living in general. We must attempt to see that we develop ways of teaching Design authentically because it is one way to make schools richer, more meaningful places for children to learn in.

PARTICIPANT 6

The aim of this part is to establish an individual participative framework (established from each research participant) for understanding the design process. The following questions will guided the discussion.

What have you learnt from participating in this focus group? What is your understanding of the design process now?

Previously from reading, study and practice I had learned that the design process is a complex process that basically cannot be reduced to a simple formula. This has been affirmed by the focus group and provided readings.

My understanding of the DP incorporates a context that is relevant to the learner – and that the process involves action and cognition whilst the learner's capabilities are stretched to develop and make innovative products to meet relevant needs.

Has it changed from your original understanding? Yes/No. Elaborate

No. See above (question 1).

1 In terms of what was discussed in part 2 regarding the different frameworks for understanding design, which frame would you say better reflect your understanding? Explain.

If I was to select from the phrases "quotes" given by the researcher, I would select that of Schon (1987) because it most accurately describes the dynamics of designing and drawing (modeling).

However, if more comprehensive quotations were given, I would choose the framework provided by the APU. (See question 4). There are aspects in each of the frameworks quoted that overlap. I am drawn to the following emphasis given in the APU – that the DP combines, "a growing range of capabilities in a way that reflects individual creativity and confident working methods." (APU 1987: 2.12).

Which framework would you use in your own practice? How? Why?

I would use the APU as a framework because it incorporates many of the significant points mentioned by the other authors. Furthermore the APU emerges out of practical and thorough research based in schools. It also presents a sound philosophy of Technology as well as addressing considerations related to applying theory in ways that inform and improve practice. I would use this framework for both practical work and assessment where it is based on holistic rather than fragmented assessment methodology.

Again, I would be inclined to use the APU because its approach to the DP provides a practical structure which is flexible and is likely to, “combine a range of capabilities reflecting individual creativity and effective working methods.” (APU 1987: 2.12).

Do you have anything that you’d like to share with the group?

I would like to comment on the practical challenges of putting excellent theory into practice. Whilst an iterative model of the DP is ideal in situations where the teacher is an expert designer – like “Quist” in Schon’s exemplar; the reality amongst South African teachers is different: They have:

(a) Limited general knowledge;

(b) Little confidence in dealing with uncertainty – what Kimbell describes as “wicked” tasks;

(c) Poor resources of skill, materials and equipment;

(d) Many are more concerned with getting a qualification that acquiring skill and capability.

These constraints in schools make it difficult to teach processes that rely on high levels of professional competence. Policy makers are therefore likely to revert to models of the DP that are highly structured and linear in order to ensure that all teachers can cope with implementation requirements.

However, if this is to be done, it must be done in ways that do not interfere with competent teachers who are able to do more to align the Design experience within their classrooms with the more complex and enriching process we see as an ideal.

Competence in the sense described above is more than pedagogical proficiency. It assumes that such teachers also have qualities (like the ability to tolerate ambiguity, work flexibly with materials and “play” with ideas) that are, to some extent dependent on personality typ

PARTICIPANT 7

The aim of this part is to establish an individual participative framework (established from each research participant) for understanding the design process. The following questions will guide the discussion.

1. **What have you learnt from participating in this focus group? What is your understanding of the design process now?**

   I enjoyed the discussion we have as a group and in discussion; I feel my understanding of the design process has broadened. I have also realized how very difficult it is to define or model and for many the models are quite varied.

   Has it changed from your original understanding? Yes/No. Elaborate

In some ways no, as most of us feel the same about the design process not being linear. In some ways yes, as I have seen from the discussion the design process can be so much more that just working through specific "steps" or "responsibilities". The discussion made we realize that how one designs depends on who they are much more than what they have learnt about design.

2. **In terms of what was discussed in part 2 regarding the different frameworks for understanding design, which frame would you say better reflect your understanding? Explain.**

   I enjoy Kimbel's model of design as it is far more open and non-linear, it also leaves room for more other designer's personality to become part of the design process. I also enjoy Hill's model of deign as I enjoy the relevance that comes with Technology tasks set in real life contexts.

3. **Which framework would you use in your own practice? How? Why?**

   What? Hill's

   How? Jungle gym project

   Why? Relevance and social Responsibility

4. Do you have anything that you'd like to share with the group?

   Success of Jungle gym project

DR RICHARD STEELE
BA, HDE, MTech(Hom)
HOMEOPATH and EDUCATOR
Registration No. A07309 HM
Practice No. 0807524
Part-time lecturer, Dept of Homeopathy, DUT
Freelance academic editor

110 Cato Road
Glenwood, Durban 4001
031-201-6508/082-928-6208
Fax 031-201-4989
Postal: P.O. Box 30043, Mayville 4058
Email: rsteele@telkomsa.net

EDITING CERTIFICATE

Re: **Bongeka Petunia Mabaso**

ACE Technology lecturers' and in-service teachers' understanding of the design process and its enactment in their pedagogical practice

I confirm that I have edited this dissertation and the references for clarity, language and layout. I am a freelance editor specialising in proofreading and editing academic documents. My original tertiary degree which I obtained at UCT was a B.A. with English as a major and I went on to complete an H.D.E. (P.G.) Sec. with English as my teaching subject. I obtained a distinction for my M.Tech. dissertation in the Department of Homeopathy at Technikon Natal in 1999 (now the Durban University of Technology). In my capacity as a part-time lecturer in the Department of Homoeopathy I have supervised numerous Master's degree dissertations.

Dr Richard Steele
16 January 2015
electronic